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A LABORATORY METHOD OF DETERMINING THE ECCENTRICITY OF A SEXTANT.

C. C. HUTCHINS.

FOR POPULAR ASTRONOMY.

In the text books of practical astronomy we find two general methods of finding the errors of eccentricity of the sextant,—first, by measuring several angles between objects in the same plane and a mile or more distant with a good theodolite, and measuring the same angles with the sextant. The errors of the latter then come out at once.

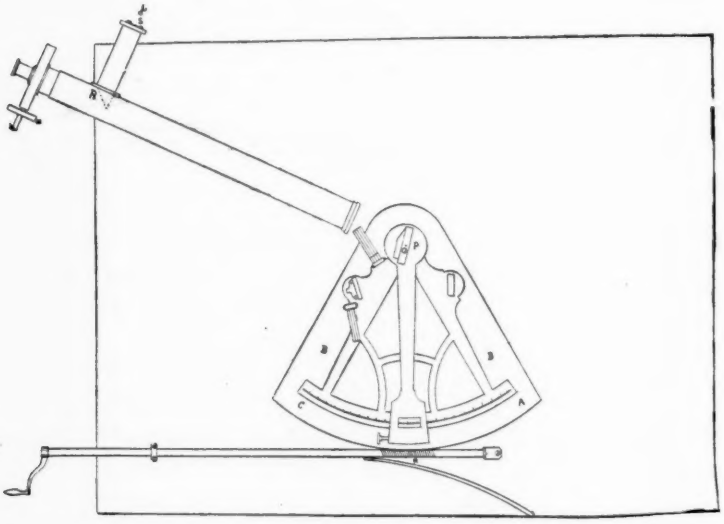
Second, by measuring distances between stars, or measuring their double altitudes, and comparing these quantities with their true values derived by calculation. The first is a good method, but places are rare where the marks can be set up, and not every one has a good theodolite. The second method requires great skill in making the observations; even a practical observer with the sextant will not unfrequently make errors of 20″ in a single measurement, and then the amount of computation makes the practice of the method very tedious, and not likely to be repeated oftener than absolute necessity demands.

I purpose to show how a very simple instrument may be constructed which will furnish directly the corrections to be applied to the sextant scale with all desirable accuracy and with minimum expenditure of time. The apparatus to be described was, with the exception of the two prisms, made by one man in a day by using such materials as were at hand in an ordinary physical laboratory and workshop. The appended diagram will make the details clear.

The base of the apparatus is an ordinary panelled pine drawing board. The sector B was made by fastening together two pieces of pine board with screws, these with the grain of the wood crossed to prevent warping. The sector rotates with a flanged pin as axis, the flange being screwed to the lower side of the sector and the pin fitting a bit of brass tube inserted in the base. O is the center of rotation. The worm screw shown was put on merely because we happened to have it; any sort of handle or even a peg inserted near it would serve every purpose quite as well.

A simple clamp, not shown, holds the sector fast to the base when it is so desired. Two brass plates of the same thickness as the flange at *O* were put under the sector at *A* and *C*, that it might have three feet to stand and move on.

Upon this sector, so provided, rests the sextant to be tested. The leg of the sextant at *O*, which leg is also the socket holding the axis of the sextant, stands directly over the axis of the sector; the remaining two legs stand in high brass hubs or sockets where they are held firmly by screws so that the instrument is immovable upon the wooden sector.



Pointing at the index glass of the sextant is a telescope of 17-inch focus, having an objective 1.5 inches in diameter, a magnifying power of 30, and furnished with a micrometer. This telescope was on hand and we merely had to put on its side the short tube furnished with a single slit and right angled prism shown respectively at *S* and *R*; thus it becomes both telescope and collimator. It is of course not necessary that the two be combined, the collimator and telescope might be borrowed temporarily from any spectroscope; and even the micrometer could be dispensed with, though very convenient.

There remains only the prism *P*. This prism has an obtuse angle of about 170° and is placed directly upon the index glass and there held by a light spring clip. This prism requires some

optical skill to cut and polish it properly, but an amateur of no great accomplishments could grind one from plate glass, and cement a piece of thin plate over the ground face, and I think good definition would be obtained.

We need to know the angle of this prism very exactly, or rather the angle formed by the perpendiculars to its two faces. Measuring this upon the spectrometer I found it to be of 57′ 19″.5 ± 0″.4. Let twice this angle be called *N*. Hence

$$n = 19^\circ\ 54'\ 39'' \pm 0''.8.$$

I need hardly say that the prism is adjusted upon the horizon glass so that its angle is parallel to the sextant axis, exactly as one adjusts a prism upon the spectrometer when measuring its angle. A slight nick in the middle of the slit aids in making the adjustment, and as it takes but a few minutes it is well to be exact about it. The method of proceeding is then as follows: A lamp is placed before the slit; the index of the sextant set at 0° and clamped. The sector is then revolved until the slit image reflected in the upper face of the prism is seen in the telescope, when the sector is clamped and the micrometer wire set upon the slit image. The index arm is then moved forward until the slit image from the lower face of the prism is brought to the micrometer wire, adjusting as carefully as possible by means of the tangent screw. As the sextant is divided to half degrees numbered as whole degrees, the reading of the arc should now be the angle *n*. The difference between the actual reading and *n* will be the error of the sextant at the reading *n*, or since *n* falls so near to 20° we can make no mistake in calling the difference, for convenience, the correction at 20°.

Now unclamp the sector and revolve it until the image from the upper face of the prism is seen again in the telescope, whence proceeding as before we find the correction at 40°, it being the difference between the sextant reading and 2*n*, and so proceed to the end of the arc. It will be noticed that any error in the prism angle becomes cumulative as we proceed, so that if it were as much as 1″, at the end of 5 steps it would amount to 5″, a quantity distinctly appreciable with a good sextant; hence the importance of knowing the prism angle very precisely.

I will now give an example of the above proceeding. The sextant was of 8-in. radius divided on platinum with gold vernier—a very finely made instrument.

	N	Sextant.	2	*d*
	° ′ ″	° ′ ″	″	″
n	19 54 39	19 54 35	45	00
2*n*	39 49 18	39 49 20	25	— 4.5

	N ° ″ ′	Sextant. ° ″ ′	2 ″	*d* ″
3*n*	59 43 57	59 44 10	15	−15.5
4*n*	79 38 28	79 38 55	50	−24.5
5*n*	99 33 15	99 33 40	40	−25.
6*n*	119 27 54	119 28 25	20	−27.

Two sets of readings were made, the seconds only being put down for the second set, (in the column marked 2), the degrees and minutes being the same. Column *d* contains the sextant corrections obtained by subtracting the mean of the sextant readings from the angles *n*. I then disturbed all the adjustments, readjusted and obtained the following set of readings, the seconds only being put down.

Sextant. ″	*d* ″	Sextant. ″	*d* ″
40	00	55	−27
25	− 7	40	−25
15	−18	25	−29

It will be observed that in no case do the differences in the second set differ from those of the first by more than 2″.5. In fact the accuracy of the method depends almost entirely upon the precision with which the sextant can be read, as with the powerful telescope employed errors of setting of more than 1″ would hardly occur; and herein is one of the strong points of the method—we do not have to depend upon the weak telescope of the sextant in making the settings.

There remains to show that the cumulative error of *n* has not affected the result. To test this I made a second prism having an angle between perpendiculars of about 50° so as to cover at one step the stretch from 0° to 100°. Employing this prism as above I got as the mean of 2 sextant readings: 100° 1′ 10″; the *n* for this prism is 100° 0′ 46″; therefore *d* is 23″.6. This differs from *d* found by the first prism at 100° only 1″.4. So close an agreement is doubtless pure accident, but it at least shows that no revision of the observations is required.

The apparatus may seem crude for such exact work, but it is so only in appearance. Where precision is required, as in the optical parts, there it is supplied, and it is a waste of energy to put good material and fine workmanship where it can do no good. Briefly, I have shown how a very simple devise may be used to determine the errors of the sextant at six points of its scale, and this with all desirable accuracy and a minimum of computation.

If the errors of any instrument should be so large or so irregular that simple interpolation will not suffice for points between those for which the errors are determined, such instrument may be safely rejected as worthless.

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METEORITES OR AEROLITES.

W. H. S. MONCK.

FOR POPULAR ASTRONOMY.

Considering the interest which attaches to falls of extraneous matter to the Earth, it is surprising that so little should have been written on the subject by astronomers and that those who have written have dealt with it so superficially. That meteorites or aerolites are meteors or shooting stars and are sufficiently treated under this general head seems to be the general opinion, though why one meteor is not merely fused but vaporized at the height of more than fifty miles while another reaches the Earth scarcely red hot is a problem that should not be passed over without some attempt at a solution. Without attempting to give any general review of the answers that have been given to this question, I will refer to a few which seem to me to be worthy of attention.

Tschermak noticed the resemblance of the stones which thus fell to volcanic products and suggested that they had been shot from volcanoes in some part of the solar system. Sir Robert Ball taking up this theory contended that the Earth itself was the only admissible source, and that terrestrial volcanoes in past ages may have been powerful enough to eject stones with the velocity necessary to prevent them from falling back again immediately. A velocity of about seven miles per second would suffice for this purpose. Such a stone, I may remark, would almost certainly move round the Sun with direct motion; for even if projected in the opposite direction from that in which the Earth was moving, it would require a velocity of about 20 miles per second to set it revolving in a retrograde orbit. And for similar reasons the planes of the orbits of these volcanic stones would not be inclined at any very high angle to the ecliptic. Unless projected with a velocity of more than 15 miles per second their orbits would belong if not to the planetary at least to the asteroidal type.

The late Professor H. A. Newton examined the history of a number of recorded stone-falls and though he rejected the theory of Ball he came to the conclusion that the majority of them were travelling with direct motion in orbits not very highly inclined to the ecliptic. This conclusion of Professor Newton's seems to me to be remarkably confirmed by some recent researches by Mr. Denning, not, however, on aerolites but on fire-balls. Now "fire-

ball" is rather an indefinite term and is used to include very bright meteors which are dissipated at a great height as well as those which approach nearer to us and in some cases actually fall. Consequently we cannot expect to meet with any universal law in the case of fireballs and should bear in mind that what is true of the majority of them may be true of aerolites without exception. Mr. Denning after noticing that notwithstanding the superior brightness of these fireballs they were not on the average as high up as ordinary meteors when first seen, further remarked that while we *met* the majority of meteors we *overtook* the majority of fireballs. This plainly implies that while the majority of visible meteors are moving in retrograde orbits, the majority of fireballs are moving in direct ones. Meteors in space are probably moving indifferently in both directions, but a moving body would in that event encounter more of those which come from the opposite direction than of those which come from the same direction; just as in walking along a train line more cars meet us than overtake us. But why do more of the meteors which overtake us assume the dimensions of fireballs than of the meteors which meet us? Pursuing his inquiries on this subject Mr. Denning reached another remarkable conclusion. Meteor-radiants generally show no preference for the Zodiac, but fireball radiants do so. Now a radiant near the Zodiac means an orbit but little inclined to the ecliptic: so that Mr. Denning has arrived at the same conclusion with regard to the orbits of fireballs that Professor Newton had arrived at with regard to the orbits of aerolites—conclusions which are in good agreement with the theory of Sir Robert Ball.

Nor do these conclusions rest merely on observation. Why are the majority of meteors fused and vaporized at great heights in the air? Owing to the heat developed by the tremendous speed with which they rush through a resisting medium—the atmosphere. The heat thus generated is for equal masses proportional to the square of the velocity. Hence the meteor which will penetrate farthest into the atmosphere and has the best chance of falling to the Earth in the solid form, is that which enters the atmosphere with the least velocity. Now, when the Earth encounters a meteor coming from an opposite direction the velocity with which they meet is always greater than that of the Earth in her orbit, and I doubt if a meteor moving with this velocity has ever reached the Earth in the solid form. But if a meteor overtakes us (unless it is moving in a very marked hyperbola) the relative velocity is always less than that of the Earth in its orbit

and the velocity is probably still less in the rare case of overtaking a meteor. Again if the orbit of the meteor had a high inclination to the ecliptic there would be a considerable thwart velocity to be destroyed by the resistance of the air and dissipation would be more probable than if the inclination were small. Direct motion and small inclination of the orbit lessen the resistance and enable the meteor to penetrate more deeply into the air without dissipation. But it is also important that the actual velocity of the meteor's motion should approach as nearly as possible to the orbital velocity of the Earth. The less difference there is between the velocity of the two moving bodies, the less will be the resistance of the air to the motion of the meteor and the greater will be the chance of the latter falling to the Earth in the solid form. I am doubtful whether any known cometary orbit would fulfil this condition. The orbits of aerolites must, I think, be rather asteroidal than cometary.

That aerolites have fallen with very little velocity and without being very highly heated cannot be doubted. Those which fell on the ice at Hessle neither melted it nor bored holes in it. Sir A. S. Herschel computed that one which fell in Zorkshire reached the Earth with a velocity of little more than 400 feet per second. The falls in many instances were almost perpendicular, the relative motion having been practically destroyed by the resistance of the air without fusing or vaporising the meteor. The small depth to which these aerolites penetrate the ground shows how moderate the velocity must have been. Many have been turned up in ploughing a field. Instances of deep burial are very rare. The sound of the fall has more than once been heard before the stone reached the Earth. The velocity of such a meteor must have been less than that of sound. I cannot believe that these aerolites were very highly heated at one stage of their flight and had time to cool before they reached the Earth; and Mr. Denning as already mentioned has pointed out that as a rule fireballs do not become visible until they have approached nearer to the Earth than ordinary meteors. I suspect that aerolites do not become visible until still nearer than the average fireball. But some undoubtedly were seen as fireballs before they fell.

Velocity is not indeed the only thing to be considered. The larger a meteor is, the less is the resistance relatively to its mass and a large meteor has thus a better chance of escaping destruction than a smaller one, provided that it is not shattered to fragments by an explosion. But even such an explosion may tend to preserve some of the fragments by projecting them in a direction

that materially lessens their velocity relative to the Earth. And a meteor composed of materials which are difficult to melt or evaporate will also stand a better chance of escaping. Still I think the rule may be laid down as almost universal that aerolites must have been moving in direct orbits whose inclinations to the ecliptic were moderate and whose mean distances from the Sun were not very great. Bodies which fulfil these conditions are more likely to be original members of the solar system than visitors from external space. They may be regarded as very minute asteroids.

Among the many thousands of meteors in the great Leonid displays of 1799, 1833 and 1866 not one is known to have reached the Earth. Some meteorites fell pretty near the date but in years when the Leonids were scanty. The reason is obvious. The Leonids seem to travel with too great velocity to reach the Earth and are all dissipated at a considerable height in the atmosphere. A similar remark seems applicable to the annual display of Perseids in August and the occasional Lyrid showers in April. If meteorites have fallen pretty near the date of these showers there was nothing else to prove the connection and there is no night in the year in which more than one meteor shower is not active. The Andromeded or Bielan meteors towards the end of November are in a more doubtful position. The velocity with which this shower enters the air is much less than that of the others just mentioned—only about 14 miles per second; and a meteorite fell at Mazapil, Mexico during the fine shower of November 27, 1885. Others have fallen about the same date but the years do not correspond with the returns of the Bielan shower and they were, moreover, stones while the Mazapil meteorite was iron. It must at all events be admitted that much more attenuated showers have been more prolific of meteorites than the Andromededs. It will probably be found that in these latter cases the relative velocity was less.

May and June are the two months in which I believe the smallest number of meteors have been observed but as regards aerolites they stand at the head of the list. August and November, the two great months for meteors, do not produce more than the average number of aerolites. There are indeed aerolite showers and some of them are probably periodic, but in no instance do they seem to correspond in date with a rich meteor shower. One hundred very slow moving meteors are more likely to produce an aerolite than ten thousand swift ones. In fact if the velocity of the meteor could be sufficiently reduced a fall

might be regarded as assured. The more closely the orbit of the meteor resembles that of the Earth the more likely it is to fall in the solid form; but the actual degree of approximation in each case remains for future inquiry.

I have noticed that two aerolite showers are often separated by about six months. In these cases it is not improbable that we encounter the same meteoric stream at both nodes; and the apparent coincidence of aerolitic falls with the Perseids and Leonids loses much of its weight when we note that in both cases there are marked aerolitic showers almost exactly six months earlier. There have also been several recent falls towards the end of May about six months before the Bielan shower. Indeed as already intimated the May aerolitic showers are more prolific than the corresponding ones in November.

I hope more attention will be paid to the subject of aerolite falls in future. There can be no doubt that a great many take place in which the stone is not found—at least until it is no longer possible to fix the date of the fall. This especially occurs at night. On the other hand observers often imagine that they see stones fall when computation shows that the meteor was dissipated at a considerable height. Very slow meteors should be carefully watched, though our estimates of velocity are liable to error. When a detonation is heard, the meteor cannot have been very distant at the time of the explosion and the lapse of time between the sight and sound will enable us to estimate the actual distance. A whirring, whistling or fizzing noise probably indicates nearer approach than a detonation. And there seems to be no doubt that in cases where the meteor was not seen (as often happens in the day time) the detonation has been mistaken for the shock of an earthquake. Slight earthquake shocks occurring at unusual places should always suggest a detonating fireball.

ON SOME JOVIAN PHENOMENA.

A. STANLEY WILLIAMS.

FOR POPULAR ASTRONOMY.

With reference to the remarks under the above title in the June number of POPULAR ASTRONOMY, with which Professor Hough has honored my paper in the April number, may I point out that I have not disputed the fact of the micrometrical method of determining longitudes on Jupiter being, in point of absolute accuracy, distinctly superior to the method of eye-estimates of tran-

sits, due to the circumstance, referred to by Professor Hough, that it is possible to multiply the measures almost indefinitely.* But one of the chief objects of my paper was to enter a respectful protest against the use of, what seemed to me to be extravagant language in referring to the accuracy attainable by the method of transits, and I submit that, even according to the facts and statements contained in Professor Hough's last article, my contentions are in the main correct, and that there is certainly nothing there to justify the use of such a word as "guessing;" or to authorize the degree of accuracy of the method of transits being likened to that of eye-estimates of the position angles and distances of double stars, much less to half the degree of accuracy attained by the latter.

With regard to the second question, however, I would point out that the extreme difference of 35 seconds in the rotation period of the *South Temperate Current*† is only got by making use of the abnormally large result of 1884; and, as has already been remarked, judging from their stated latitude, the spots giving this discordant result were probably not within what I have termed the *South Temperate Current* at all. And I would emphasize the fact that, with this solitary exception, *all the other results* contained in my table, thirty in number, agree in showing a decided drift relative to the red spot in the direction of the planet's rotation! It should be remarked that I have never contended that the velocity of the drift of any particular current is invariable, or exactly the same all around the planet. But surely the mere fact of there being, as in the present case, comparatively small local or temporary variations in the velocity of the drift of a current, cannot be held to disprove the existence of the latter? Take, for instance, the case of the Trade Winds of our own Earth. The wind may blow with varying velocity in different places, but I have never heard of the existence of these winds, or

* The writer had no wish or intention to depreciate the importance of accuracy in Jovian work. On the contrary it cannot be too strongly insisted on, and if a few of the numerous fine telescopes and micrometers, for which the United States are so deservedly famed, could be applied to extending and supplementing the magnificent results already achieved by Professor Hough, no one could welcome the fact more heartily than the writer; though it is questionable whether the greatest attainable accuracy of measurement is either necessary or warranted with such mobile and variable objects as the Jovian spots, any more than it is in the case of the still more changeable solar spots.

† By an error or misprint this current is designated the *South Equatorial Current* in the April number of POPULAR ASTRONOMY, p. 193. Also the year of the first two results on p. 194 should be 1899, instead of 1898 as printed.

currents, being disputed on such grounds. Very similarly the law of the solar rotation discovered by Carrington is generally admitted, although it is well known that the motion or drift of individual spots may be far from exactly conforming to it, and in some instances the motion of solar spots may be said to be a function of the time, much as in the case of those on Jupiter.

Now that Jupiter is coming round into a position more favorable for observation than has been the case for some years, might I suggest to observers the desirability of systematically observing the spots and markings in the latitude of the south temperate belt? It is only by observation that the question in dispute can be settled, and I have no hesitation in predicting that every spot visible in this locality will be found to drift slowly but surely relative to the red spot in the direction of the planet's rotation. A few observations that have already been obtained here under unfavorable circumstances indicate that there will be no lack of prominent spots in the locality indicated, suitable for the accurate determination of their rotation periods.

HOVE, June 23, 1903.

RECENT ASTRONOMY.

WM. W. PAYNE.

A suggestive article on stellar revolutions within the Galaxy, by Frank W. Very, appeared in the August number of *The American Journal of Science.*

The article refers, in the first place, to the attempts that have been made to get some definite idea of the size of that great stream of stars we call the Milky Way. This has been done by guessing at the total mass of the stars, by studying how the stars are distributed in the heavens, by observing carefully the stars that have the more rapid motion, and in various other ways, open to the ingenuity of the scholars they have formed some preliminary notion of the dimensions of the stellar universe that must depend very largely on the guesses that underlie all such methods of astronomical work.

Heretofore it has not been known that the parallax of any star in or near the gallactic stream could be found. Now, some astronomers think it safe to say that Nova Persei of 1901 does give us the first example of a star whose parallax has been found within a reasonable degree of certainty and that it is somewhat less than one second of arc, and that it either lies in the great starry stream, or on a side branch of it relatively near.

The study of the parallax of that nova was an interesting one, and Professor Very brings out the point well in the article referred to. He uses the observations of Perrine and the photograph of Ritchey for data, and shows that the arch of Perrine and the nebulous rings by Ritchey which were undoubtedly driven away from the Nova and were measured at different times and by different persons, give results agreeing well in parallax. From these computations Professor Very adopts the parallax 0″.05 for the Nova, and that part of the Milky Way where the star is supposed to be located.

His next point is to form some idea of the structure of the Galactic System, and the nature of motions within it. In this study it is necessary to depend on the total proper motion of the stars which is the best criterion of stellar distance now known to astronomers. He uses Kapteyn's investigations to show the proper motions of stars of different classes, and names those of peculiar interest in this study. He experiences what other astronomers have said: "We need more observations of the stars so as to determine stellar motion more generally and more definitely." But in this study Very emphasizes the fact that a large number of Galactic first-type stars should have their motions measured radically and for proper motion.

For "Kapteyn has shown that between magnitudes 0 and 6.5, there are 19.3 times as many stars of type II as of type I having annual proper motion than 0″.50, but only 0.6 as many with proper motion less than 0″.03. This taken in connection with the galactic condensation of the first-type stars, doubtless means, primarily, that there are comparatively few stars of the first type outside of the Galaxy."

From such facts as these the need of more observations becomes plainly evident. After this consideration of general principles Professor Very takes up the mechanism of the Galaxy more in detail.

He considers its form and structure from the analogy of nebular forms; *i. e.*, is it spiral or annular in its major stream? In either case it is uniplanar. As a complete system it is divisible into stellar streams with interlacing movements which form a kind of envelope to the more condensed portions that may be in spheroidal form, the outer part of which may extend possibly to a distance ten times as great as the radius of the condensed nucleus. This concept of the form of the Galaxy and the general notion of its structure is put, nearly in the language of the author of the paper, only somewhat shortened.

It differs but little from that held by other astronomers as far as we know.

But the next point, the assumption in the stellar universe that there are both motions of approach to, and dispersal from, attractive centers is worked out more fully than any other having fallen under our notice. The attractive motions in the starry fields of the Milky Way shown by the tendency of the stars to cluster forming groups of various kinds that are everywhere to be seen is easily believed to be a consequence of the attraction of gravity; but the dispersal of stellar bodies, "after a certain limiting magnitude of mass has been" reached, is not so obvious. Professor Very supposes that the "result of agglomeration," presumably due to great pressure and high temperature, may set in action explosive or repulsive forces that will cause stellar dispersion. The proof given for this is the structure of stellar clusters, which contain no single star of surpassing magnitude, as in the solar system, and from the development of clusters, as inferred from the spectra of stars composing them, the less condensed clusters having more advanced spectra, indicating that the progression of a group of stars is towards more complete separation. If we can be sure that clusters generally age, disperse and have an advancing spectra at the same time this will be a strong proof of the truth of this astonishing claim.

This point in the discussion is so important that it must be well fortified to win general acceptance. It is the basis of the consequences that are presented in the remainder of the paper with clearness and effect.

At another time we wish to consider further some of the consequences of this theory of combined stellar concentration and dispersal.

In *Bulletin* number one from Lowell Observatory, Flagstaff, Arizona, is found an article by Mr. Lowell, minutely descriptive of a projection on the planet Mars.

In the latter part of May, V. M. Slipher noticed a large projection about half way down the terminator of the planet. Mr. Lowell was immediately notified and thereafter it was watched for three days. Mr. Lowell said of it, "The thing that first impressed me was its size. It was excessive both in length and in height. It consisted of a long band of light a little north of the center of the arc of the phase ellipse, lying parallel to the terminator but parted from it by a dark line half the band's own width." Its color was ochre-orange. The seeing was 5 on the scale of 10, the instrument used was the 24-inch equatorial with

a power of 310. As soon as possible after discovery micrometric measures were begun to determine the length and place of the object, and this work was kept up during visibility. Drawings were also made at different times.

From the observations computations were made which showed that the height of the projection was about 17 miles, and that its place

May 26 15^h 41^m was 18° 31′ N. lat. 39° 45′ long.
48 " 19 44 " 39 59 "
16 10 " 21 24 " 40 33 "

From these measures the center of the projection had changed its place during the time of these observations. It had moved in a northwesterly direction.

At 15^h 51^m Mr. Lowell measured the length of the projection and found it to be 8°.2 equalling 300 miles.

The observations on the following day were not as good as those already given, though the seeing, at times, was rated the same. Comparing the observations of the two nights, it seems that the projection moved 7° in latitude and 8° in longitude, equalling a distance of 390 miles, a rate of 16 miles per hour.

From a study of these observations Mr. Lowell thinks the phenomenon was an enormous cloud travelling northeast, and dissipating as it went.

The closing part of Mr. Lowell's description is as follows:

"It is of interest to inquire under what conditions, diurnal and seasonal, the cloud came into being. As to the time of day, the terminator in question was the sunrise one. The cloud, therefore, was first seen when it was half an hour before sunrise upon its part of the planet, and continued to be visible up to the rising of the Sun. The place was within the tropics, in the desert region to the south of the Lacus Niliacus. With regard to the Martian season of the year it was, in this the northern hemisphere of the planet, at the time, according to the data of Crommelin's excellent ephemeris, what corresponds to the first of August with us and the Sun was over head in latitude 18° 7′ N. The cloud, then, when first seen was almost exactly under the Sun. It then traveled north, dissipating as it went, and was practically dissolved again by the time it had reached 25° N. latitude.

"Finally its color leads me to believe it not a cloud of water-vapor but a cloud of dust. Other phenomena of the planet bear out this supposition.

"On May 28th no trace of it could be perceived by Mr. Slipher."

DR. ANDREW AINSLIE COMMON.

H. H. TURNER.

On Tuesday, June 2, 1903, Dr. Andrew Ainslie Common died very suddenly from heart failure. He had been in excellent health and there had been no warning whatever of impending danger.

He was born at Newcastle on August 7, 1841. He went into business as a sanitary engineer and was fairly successful. He became interested in astronomy about 1874 and had a 5½-inch refractor mounted equatorially in a dome in London. Afterwards he moved to Ealing and set up an 18-inch reflector by Calver. He joined the Royal Astronomical Society in 1876 and soon began to contribute observations of the satellites of Mars and Saturn: but with the 18-inch he found he could not well see the inner satellite of Mars and he ordered a 36-inch mirror from Mr. Calver. The design for the mounting was his own (Mem. R. A. S. Vol. XLVI). With this instrument he did a great deal of valuable work. He made visual observations of the satellites of Mars and Saturn, and noted the nebulæ in the Pleiades: but it was his photographs of nebulæ, taken with this instrument, which made him famous. For his beautiful picture of the nebula in Orion he obtained the Gold Medal of the Royal Astronomical Society in 1884. Soon afterwards he sold this instrument to Mr. E. Crossley of Halifax, who afterwards presented it to the Lick Observatory, where it has done valuable work in the hands of the late Professor Keeler and others. But it should be mentioned that the mirror now in use is not Mr. Calver's orginal mirror.

After a year's relaxation from the close attention he had paid to astronomical photography Dr. Common determined to venture on a larger instrument, aperture 5-feet; and further that he would make the mirror himself. He has described the difficulties he met with, and successively overcame, in his memoir "On the Construction of a five-foot Equatorial Reflecting Telescope," (Mem. R. A. S. Vol. L). The instrument was completed in 1891 and excellent photographs obtained with it; but little or nothing was published because Dr. Common thought these early results could be improved. His work was interrupted in 1893 by a narrow escape from falling from the high staging necessary to work a Newtonian telescope at the eye-end; and he determined that the telescope must in future be worked from the lower end, to ensure the safety of the observer. He prepared therefore to use the telescope as a Cassegrain; and first he hoped for an "oblique"

Cassegrain (see *Monthly Notices R. A. S.*, Vol. LV., p. 86, etc) but could not get quite good enough results in this way. He therefore proceeded to make a new 5-foot mirror with a hole in the center and completed the telescope in this way as an ordinary Cassegrain. But about this time he became much interested in telescopes for use with artillery and fire arms generally; and this new interest practically absorbed all his energies, so that the 5-foot telescope has not yet been much used.

As an observer Dr. Common was quick to seize the suggestions of experience. The discovery of a comet at the total solar eclipse of May 16, 1882, suggested to him to search the neighborhood of the Sun for bright comets, which he did assiduously; and he was rewarded on September 17 of the same year by the independent discovery of the great comet of 1882 (see *Observatory*, Vol. V, p. 319 and *Astr. Nach.*, Bd. 103, p. 159). He was thus the first to see it in Europe although the comet had been previously noticed at the southern hemisphere.

Dr. Common took a great interest in eclipse work. He went to Norway in 1896 to observe the total eclipse of that year, but was disappointed by clouds. But he took a large share in organizing all the British eclipse expeditions from 1889 onwards; and many of the instruments, especially the coelostats recently used by English observers, were made either actually by him or from his designs. He made a large number of mirrors for others, many of which he generously presented to the recipients. Perhaps the two most remarkable were those of 20-inch aperture and 45-inches focus provided for the eclipse of 1889.

He took a prominent part in the Conferences of the International Committee for the Astrographic Chart; and although he did not take any share in the actual work, it may be mentioned that he had himself started on a scheme for charting the sky, which, however, he put aside after the conference of 1887. At that conference he and Mr. Janssen were appointed a committee for dealing with all astronomical photography outside the work of the chart.

He was treasurer of the Royal Astronomical Society from 1884 to 1895, when he was made president. He was elected Fellow of the Royal Society in 1885. He leaves a widow, one son, and three daughters.

UNIVERSITY OBSERVATORY, Oxford,
1903, June 28.

MANNER OF MAKING OF THE POLAR CAPS OF MARS.

PERCIVAL LOWELL.

On July 5th, at $14^h\ 18^m$ G. M. T., was made what proved to be, for some time, the last measure of the old north polar cap of the planet. At $14^h\ 16^m$, it seemed to me unusually small, and upon measuring it with the micrometer, I found it to subtend only ″.29 of arc. As the diameter of the disk was then 8″.14, on the basis of 9″.30 at distance unity, ″.29 of arc gave for the diameter of the cap perpendicular to the then longitude, 292°, 4°.1 of the planet's surface. The measure was made between the threads of the micrometer instead of from centre to centre of the threads, a device which eliminated the effect of irradiation. No correction for the latter has therefore to be applied.

The cap was well seen and showed sharply contoured by a dark band as usual. For the last ten days it had been diminishing slowly in size and was, moreover, of a somewhat elliptical figure. Both characteristics appear from a comparison of the micrometric measures made of it at about the same hour of the evening from June 26 to July 5, and tabulated as follows:

Date.	Longitude Center of Disk.	Size in Seconds.	Size in Degrees upon the Planet.
	°	″	°
June 26	$\lambda = 16$	.49	6.5
27	$\lambda = 356$	.47	6.3
30	$\lambda = 325$	.43	5.9
30	$\lambda = 336$	.45	6.1
July 1	$\lambda = 331$	.38	5.2
2	$\lambda = 323$	.35	4.8
5	$\lambda = 292$	.29	4.1

For weeks it had stood flanked round about by subsidiary white patches, several of them substantially where Schiaparelli had noted them in 1888. These had waxed and waned, come and gone with chronological irregularity, and without, on the whole, noticeable increase or decrease of the total area occupied by them. Nor at the time of the measure of July 5th had any striking change taken place in this state of things. But about half an hour afterward, at $14^h\ 39^m$ G. M. T., there became visible near the terminator a large white patch north of Arethusa Lacus and trenching upon the Pierius-Callirrhoe, where at the time of the last observation of that longitude on July 3d (no observation was made on July 4th) I did not remember any white area of that magnitude to have been. As the planet's rotation brought this region into better view, the occurrence of recent and extensive

change grew momently more plain.. It became clear that in the last forty-eight hours a white deposit had taken place over a region many hundred miles square in the arctic and north temperate zones of the planet, in longitude 340°. The white area stretched from the neighborhood of the north polar cap to latitude 55° N. It even crossed the Pierius to the south, while at the same time that canal could, with attention, be seen running through it. Of the significance of this latter fact it is sufficient to note that it disclosed two things—first, that the white area was not due to cloud but to a deposit upon the ground itself, presumably hoar frost, since had it been cloud, it must have hid impartially light and dark areas alike. Secondly, that this deposit was probably at least twenty-four hours old. For at the time of detection it was morning in that part of the planet, which, consequently, had not been long subjected to the rays of the Sun. It would, therefore, not have had time to melt over Pierius had it been solely the work of the night before. That the Pierius did cause the deposit to melt, and thus to show itself as a dark line across the tongue of white thrust forth from the north, finds the same explanation as that for the rifts in the polar cap*, to-wit: the presence there of vegetation. That the Pierius had caused the deposit to disappear above it is sufficiently testified to by the otherwise uniform contour of the white patch through which the Pierius had the look of an after-line.

The old polar cap was sharply differentiated from the newly fallen frost by its usually dark girdling band. This condition, however, did not continue. On July 7th, at the beginning of observations, it was not possible to secure any meridian transits of markings, owing to the impossibility of recognizing the old polar cap amid the large white areas about it. It was not till $13^h\ 16^m$ that it came out. On July 8th, this lack of differentiation had increased. At $16^h\ 15^m$, the "snowcap" was "almost indistinguishable from the white about it." On July 9th, the merging seemed complete, for at $13^h\ 11^m$, at the beginning of the observations, the polar cap was "indecipherable from the snow about it," and it continued thus to the close at $16^h\ 13^m$, when the "cap" was "as indeterminate as ever." Much the same it showed on July 10, 11, 12 and 13. On the last date, for example, at $14^h\ 17^m$, my notes state that "the polar cap comes out but confusedly as if no dark line marked it off," and also that there was a "broad white collar including the cap, not so brilliant as the cap at times." Finally on

* Cf. Arctic canals and north polar rifts by the writer.

July 16th, I have: "North polar snows diffuse and indefinite; no polar sea nor definite cap, only more brilliant where the cap was," and on July 17: "No old polar cap visible, (new) north cap very pale." Here, then, we have the spectacle of the ending of the old polar cap and of the beginning of the new. The observations determine not only the date of the occurrence, but show the method of its action. As to the date, the event took place between July 3d and 5th, and probably in the night between July 3d and 4th. This was 127 days after the summer solstice of the northern hemisphere. Such corresponds to the 20th of August with us. The Sun had then gone south to the 12°.5 parallel of latitude north. This, therefore, was the date of the first systematic frost, the date of the beginning of the deposition of the new polar cap.

The date, August 20th, gives us an insight into the temperature conditions of the planet. For it enables us to form some idea of when the mean temperature falls permanently below 32° Fahrenheit in the sub-arctic and extreme north temperate zones of the planet. (The supposition that any other substance than H_2O constitutes the polar cap is not sustained by the *ensemble* of the observations, while that of water is so far in perfect keeping with them. Consequently, we have every reason to suppose the deposition temperature to be 32° Fahrenheit). Comparison with the climatic conditions on our Earth is affected, first, by the presence here of large bodies of water, which are absent on Mars, and secondly, by the much thicker blanket of air with which the Earth is wrapped about.

The method of the new cap's formation is noteworthy, for it falls in line with our latest conceptions of Martian physiography. The deposit took place, not at the fringing edge of the old cap, thus to extend it, but, simultaneously over a wide area in the arctic and north temperate regions. In the longitude covered by it, it stretched down to latitude 55° N, or over a number of degrees nearly co-extensive with the greatest diameter the cap ever attains. It thus exemplified the essentially superficial character of the cap. That cap is formed by successive layers of a substance which it is only rational to suppose to be frost, having at its center a small kernel of perpetual snow. When the cap begins to be, in the early autumn of its year, it forms irrespective of the old nucleus which it envelops and soon covers up. More than one of these new sheets of hoar frost appears from the observations to have been deposited in the course of the time from July 3d to July 17th. At first the old cap was not obliterated nor even

dimmed; gradually, however, it grew more and more indistinguishable, and finally became only the brighter boss of the new white shield, when indeed it was recognizable at all. As we should expect, if frost it be, the newly deposited frost lacked the sheen of the weathered and ice-welded older snow. It is worth noting that carbonic acid gas would not exhibit these phenomena since under such pressures as must exist on Mars, that substance does not melt, as was the case over the Pierius, but passes practically instantaneously from the solid to the gaseous state.

The fact that the Martian north polar cap is composed of a perpetual kernel and a periodic husk, explains the quick melting of the outer portion of the cap and the long lingering of the inner part.—*Lowell Observatory Bulletin, No. 2.*

FLAGSTAFF, Arizona, July 18, 1903.

SUNSPOTS IN JULY.

J. F. LANNEAU.

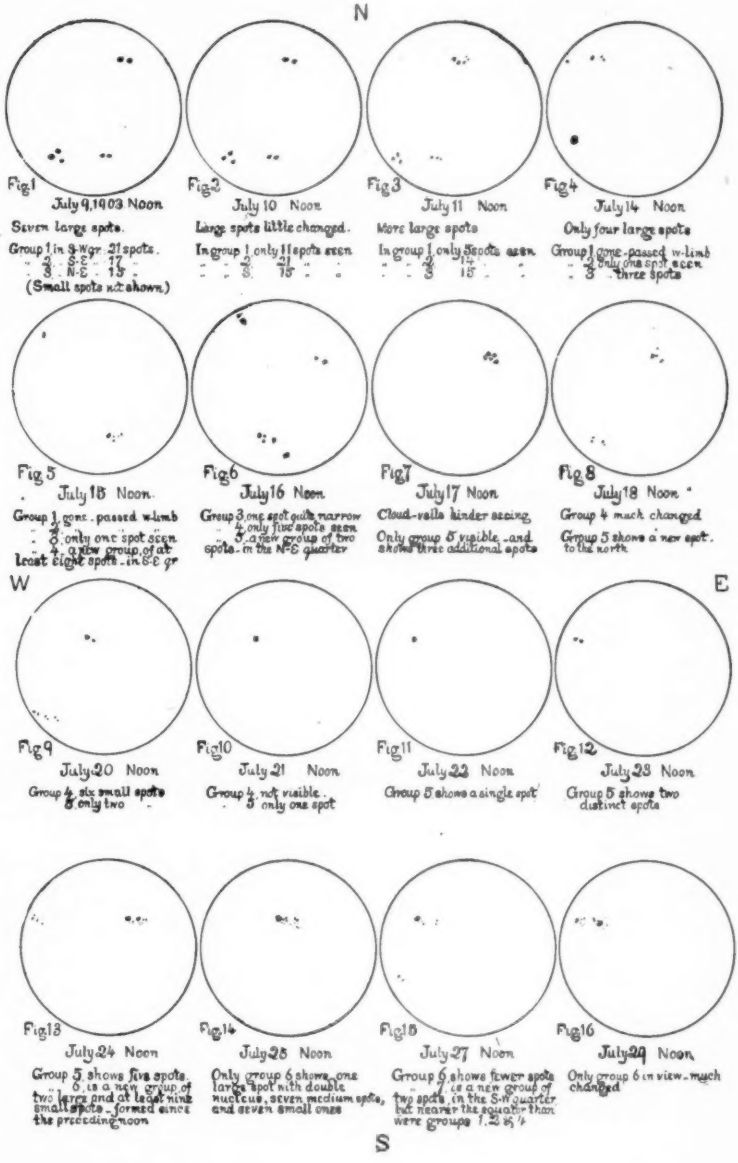
FOR POPULAR ASTRONOMY.

The last maximum of sun-spottedness occurred in or near the year 1893. Few or no spots appeared on the Sun during 1900. Few have formed since that date. Just now there is a marked revival of solar activity.

North Carolina's sky gives good seeing, but during July it has been marred almost daily by shifting cloud-veils.

Still as viewed from Wake Forest through a five-inch telescope July 1st there was a single spot on the Sun's disk and on the 9th, three groups. The relative positions of those seen on the 9th are shown in Fig. I. They were located approximately by simply noting the transits of the leading spots and of the nearest limb, east or west as most convenient. Distances north and south are eye estimates. Only the larger and in some groups the more distinct of the smaller spots, are shown in the accompanying drawings. In each figure the Sun's disk is inverted east and west but not inverted north and south—due to the eyepiece used.

In Fig. I, group 1—that is, the group on the left—contained twenty-one spots, only three of them large. Group 2 had seventeen spots, and group 3, on the right, fifteen. But in group 2, and also in group 3, there were only two large spots, as shown. Some of the changes from day to day in size, shape and number of spots in a group may be noted by comparing successive figures.


N
W
E
S
Fig 1
July 9, 1903 Noon
Seven large spots.
Group 1 in S.W qr. 21 spots.
" 2 S.E. 17 "
" 3 N.E. 15 "
(Small spots not shown)
Fig 2
July 10 Noon
Large spots little changed.
In group 1 only 11 spots seen
" " 2 21 " "
" " 3 15 " "
Fig 3
July 11 Noon
More large spots
In group 1 only 5 spots seen
" " 2 12 " "
" " 3 15 " "
Fig 4
July 14 Noon
Only four large spots
Group 1 gone-passed w-limb
" 2 only one spot seen
" 3 three spots
Fig 5
July 15 Noon
Group 1 gone - passed w-limb
" 2 only one spot seen
" 3 a new group of at least eight spots - in S.E qr
Fig 6
July 16 Noon
Group 3 one spot quite narrow
" 4 only five spots seen
" 5 a new group of two spots - in the N.E quarter
Fig 7
July 17 Noon
Cloud-veils hinder seeing
Only group 5 visible - and shows three additional spots
Fig 8
July 18 Noon
Group 4 much changed
Group 5 shows a new spot - to the north
Fig 9
July 20 Noon
Group 4 six small spots
" 5 only two
Fig 10
July 21 Noon
Group 4 not visible
" 5 only one spot
Fig 11
July 23 Noon
Group 5 shows a single spot
Fig 12
July 23 Noon
Group 5 shows two distinct spots
Fig 13
July 24 Noon
Group 5 shows five spots
" 6 is a new group of two large and at least nine small spots - formed since the preceding noon
Fig 14
July 25 Noon
Only group 6 shows - one large spot with double nucleus, seven medium spots, and seven small ones
Fig 15
July 27 Noon
Group 6 shows fewer spots
" 7 is a new group of two spots, in the S.W quarter but nearer the equator than were groups 1, 2 & 4
Fig 16
July 29 Noon
Only group 6 in view - much changed

Since each group gradually shifts westward, crossing the disk in about two weeks, the Sun turns on its axis in about twenty-seven days.

Since the southeast quarter (Fig. 4) was immaculate at noon on the 14th, group 4 (Fig. 5) seen on the 15th was formed between the noons—that is, by a fresh outburst of solar activity. So too, with group 5 in Fig. 6, and group 6 in Fig. 13, and perhaps group 7 in Fig. 15.

Since the Sun's disk, measuring nearly a million miles across, has an area of more than five hundred thousand millions of square miles, a seeming *small* spot covers an area of some hundreds of millions of square miles.

Since a group of spots forms quickly, and each spot soon changes in size and contour, the yielding surface matter is seemingly disrupted or rent assunder by furious pent up forces temporarily triumphant.

Solar activities are now likely to increase more or less steadily from month to month until 1904-5, when doubtless there will be another maximum of sunspots, for the period from one maximum to the next is about eleven years.

Successive maxima of spottedness are not equally marked. Solar questions multiply. Interest in sunspot study grows and deepens.

SOLAR AND TERRESTRIAL PHYSICAL PROCESSES.

WM. W. PAYNE.

A thoughtful paper on studies of the meteorological effects of the solar and terrestrial physical processes as observed in the United States was presented by Professor Frank H. Bigelow before the Physics Section of the American Association for the Advancement of Science at the meeting in Washington, D. C., December 28, 1902. It was printed in the *Monthly Weather Review* for December 1902 and January and February 1903, but, unfortunately we did not see copies of the *Review* for those months and did not know of the paper until it appeared in the Weather Bureau Publication, No. 290.

There are points in it which the astronomer and physicist alike should have in mind in practical research, and so we restate some of the leading points made, and especially refer the interested reader to the entire paper for further information that may be desired.

Under the head of the semi-diurnal periods of the Earth's atmosphere, the following figure is presented, which shows the average curves deduced from the surface observations, as they have been repeatedly made in all parts of the tropical and tem-

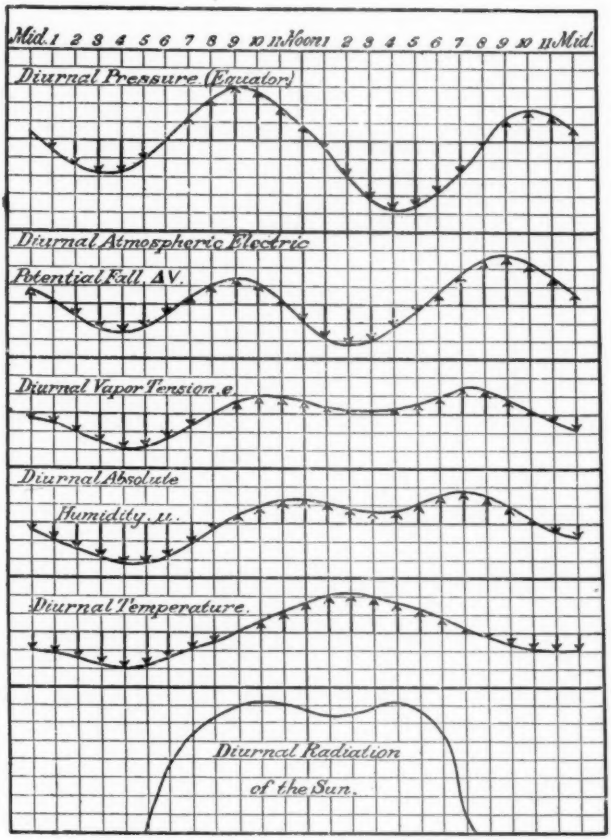

Mid. 1 2 3 4 5 6 7 8 9 10 11 Noon 1 2 3 4 5 6 7 8 9 10 11 Mid.
Diurnal Pressure (Equator)
Diurnal Atmospheric Electric
Potential Fall, ΔV.
Diurnal Vapor Tension, e.
Diurnal Absolute
Humidity, u.
Diurnal Temperature.
Diurnal Radiation
of the Sun.

FIG. 1.—DIURNAL VARIATIONS OF THE METEOROLOGICAL ELEMENTS IN THE ATMOSPHERE AT THE SURFACE OF THE EARTH.

perate zones of the Earth. If we think of the rising and setting of the Sun, on the average, as at 6 o'clock, the diurnal atmospheric processes lay behind the Sun several hours, just as the seasonal processes appear forty or fifty days later than the annual temperature changes. From this figure it is seen that while the

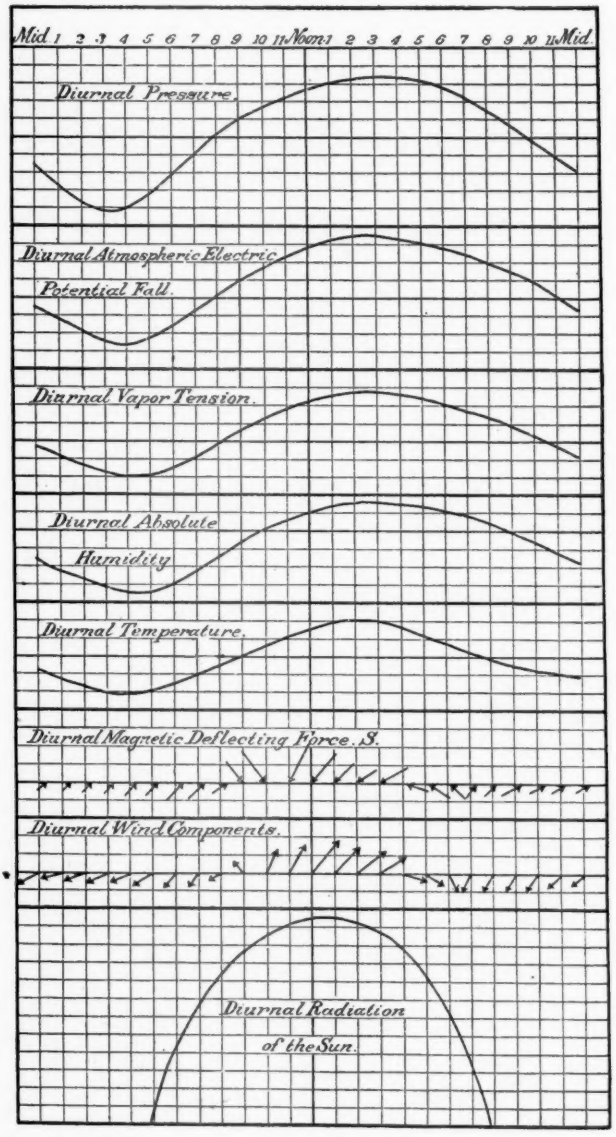

Mid 1 2 3 4 5 6 7 8 9 10 11 Noon 1 2 3 4 5 6 7 8 9 10 11 Mid.
Diurnal Pressure.
Diurnal Atmospheric Electric Potential Fall.
Diurnal Vapor Tension.
Diurnal Absolute Humidity
Diurnal Temperature.
Diurnal Magnetic Deflecting Force. S.
Diurnal Wind Components.
Diurnal Radiation of the Sun.

FIG. 2.—DIURNAL VARIATIONS OF THE METEOROLOGICAL, ELECTRICAL AND MAGNETIC ELEMENTS IN THE ATMOSPHERE AT SOME DISTANCE ABOVE THE GROUND.

pressure, vapor tension and electrical potential give a decided double period of maxima and of minima, at 10 A. M. and 8 to 10 P. M. and at 4 A. M, and 4 P. M., the diurnal actinic radiation from the Sun shows only a small midday depression and the temperature none at all, for this is a curve of a single maximum at 3 P. M. and a minimum at 4 A. M. These facts suggest the main problem to be solved: Why is it that there are single and double periods at the same time in the lower strata of the atmosphere?

It has been recently learned that the single period prevails throughout the atmosphere except in the lowest layers. The reason for the double periods has been sought by eminent physicists, for years, without success. Professor Bigelow thinks that the trouble may lie "in the fact that the necessary observations have not been made in the right place." In study heretofore, it was supposed that the observations made at the surface of the Earth, would apply equally well to strata of air at considerable heights, but, this is found not to be the case, as is shown by the curves in Fig. 2. This cut is based on data easily accessible, and for this reason authorities are not mentioned. This cut presents the interesting and comparatively new fact that when we ascend through the Earth's atmosphere "all the double diurnal periods become single periods, which takes place at comparatively low elevation. It is said that "at the top of Eifel Tower the double periods greatly weaken or entirely disappear and at the elevation of one or two miles, where the conventional ascents of the aqueous vapor contents of the air cease to form cumulus clouds, only the single period seems to exist. The truncated actinometer curve with serrated top (Fig. 1) becomes the parabolic curve (Fig. 2), even at the surface of the Earth when observed in very dry atmosphere; the barometric pressure curve, and the vapor tension, or the absolute humidity curves synchronize with the surface temperature curve, which itself retains the single period as high up as any diurnal variations occur, and the electric potential fall becomes a single period curve at surprisingly short distance above the surface of the Earth. Finally in the temperate zones the diurnal wind components, and the magnetic deflecting vectors of the Earth's magnetic field, not only agree together as vectors constituting a single system, but they also synchronize in their turning points and phases with all other elements just mentioned."

This quotation from Professor Bigelow's paper is made to show more fully and particularly the relations of these elements

in the preceding cuts, and to bring the problem distinctly to mind, why it is that there is a transformation of the double to the single period in the lower strata of the atmosphere.

Professor Bigelow's own views of the relation of solar radiation to this question will certainly interest our readers:

"In my judgment there can be but one line of argument that needs to be discussed, namely, the behavior of the aqueous vapor in the presence of the solar and the terrestrial radiations. The water content of the atmosphere at any elevation is determined by the temperature and humidity of the air, and therefore the unit volumes containing equal vapor contents stand upon isothermal surfaces which span the tropics in great arches, stretching from the north polar zone to the south polar zone. These vapor contents rise daily from lower to higher levels during the forenoon and midday, but sink back again during the afternoon and evening hours. The process is well understood and it is briefly as follows: The incoming solar radiation of short waves penetrates the Earth's atmosphere, with depletion of the short waves by selective reflection, and of the long waves by the absorption in the aqueous vapor; the Earth's surface is heated by the residue of the radiation, and it then radiates like a black body at its own temperature, which being relatively low limits the outward radiation to much longer terrestrial waves than the incoming solar rays. The heat received at the surface also evaporates the water of the surface, heats the lower strata, and raises the isotherms by convection currents as well as by radiation, till at the average elevation of 1000 to 2000 meters the vapor tends to condense or actually forms the visible clouds. The outgoing radiation is also depleted by aqueous vapor absorption, and this with greatly increased vigor at the level where the water vapor turns into liquid water in the first stage of condensation. We have, therefore, a daily rise and fall of the vapor in the lower atmosphere, and it is the behavior of this vapor blanket which must be studied carefully to account for the transformation of the double daily into the single daily periods described above."

Professor Bigelow takes up more fully the peculiarities of the terrestrial and solar radiations, in the next place, and discusses mathematically the radiation function in the normal spectrum, which comes out in the form of a ratio of the maximum radiation occurring in the spectrum of a black to the total radiation throughout the whole spectrum from a unit surface of a black body. The formulæ obtained when tested up to a temperature of

1500° appear to be satisfactory, but for the higher solar temperatures this is no longer the case. It is suggested as a possible reason for this, that there may be a breakdown in the molecular structure of so-called black bodies at very high temperatures which cause them to emit different spectra curves from those computed by these formulæ. If this supposition should prove true, a very important point at once arises, which is the necessity of being "very cautious in computing the value of the solar constant, at the distance of the Earth, from formulæ deduced in our laboratories and applied to the Sun as to a common black body."

From the mathematical work just referred to the solar and terrestrial curves for various temperatures were constructed, for the incoming radiation of the Sun ranging from 8000° to 3000° and for the outgoing radiation from the Earth within a range of 383° to 198° absolute temperature. The results are given in tables and platted curves that follow bringing out many interesting facts, and remarks on the solar constant that are full of interest to those who are able to grapple with pending abstruse problems of solar physics. We hope this important theme will be pursued earnestly much further. It seems to be worthy of it in the directions indicated in this paper.

A METHOD OF OBTAINING THE FOCAL POINT OF A LENS OF LONG FOCUS.

GEORGE A. HILL.

[Published by permission of Rear Admiral C. M. Chester, Superintendent].

Recently I have had occasion to establish the focal point of a single lens, five inches in diameter, and 325 feet focus. The lens has been mounted in the plane of the prime vertical, at the Naval Observatory, and it is to be used for the purpose of keeping control on the change in azimuth of the Prime Vertical Transit Instrument, as well as a check on the error of collimation.

While on the surface it may appear a simple operation to place a mire mark in the focal plane of a lens of this extremely long focus, nevertheless, upon trial it will not prove to be so easy a matter.

Moreover, I do not remember of reading in recent literature a suggested mode of how to proceed to locate the focal plane of a lens whose rays are so slowly coming to a point, and I have thought it might be of interest to give the plan I have followed.

After the glass had been carefully centered in its cell, with re-

spect to the one in the transit instrument, I placed on either side of the approximate focus of the azimuth lens a board, six inches wide, and five feet long.

To this I fastened, at intervals of one foot, short pieces of wood, in an upright position, on which were tacked small white cards, having printed on their face, words in different size type, similar to those used by opticians in testing the eye sight.

On the cards the font of type range from full head line to the smallest size.

The upright board, nearest the lens, was made the same size as the card, about three inches, the next board twice the height of the first, and so on for all the boards, there being five. In other words the board would have the appearance of the risers for a pair of steps.

To permit of all of them being seen at the same time, I computed the linear width of the field of the transit instrument, at the focal plane of the lens, and made the vertical height between the first and last board to come within that limit. Therefore, looking through the transit instrument, pointed on the long focus lens, the observer would see five cards, one above the other, and at a horizontal distance of five feet between the first and the last.

In locating the approximate focal point of a lens of the above construction, it is more expedient to be able to compare the distinctness of the images of all the cards at one time, rather than to attempt to carry the impression in the mind, from one to the other moving the telescope in zenith distance for that purpose. With all the cards seen in the field of view the observer will very quickly pick out the two that approximate to the proper focus.

The above is a preliminary test, and after it was made, I placed in the interval covered by the two cards of sharpest definition, a board, about 14 inches long, six inches wide, and to which were attached similar upright boards, as explained for the first one, but at intervals of three inches.

Through each of the small boards a half-inch hole was bored, each about two inches above the one below, and over which were pasted strips of dead black paper. I used that which is employed in wrapping photographic plates.

With the aid of a very fine needle a small hole was pierced through each of the pieces of paper, and behind which were placed a group of small electric lights, for the purpose of producing an artificial star.

Looking through the transit, after this piece of apparatus was

in position, and illuminated, the observer would see a group of artificial stars, one above the other, their distance apart, for successive ones, being narrowed down to three inches.

After selecting the adjacent images that gave the sharpest defraction rings, the other lights were taken away, and with the aid of an assistant, who moved the board backward or forward the interval of the space of three inches, the most satisfactory point at which to place the mire mark was secured.

To bring a lens of this long focus into use it is necessary to proceed by these successive steps, for the reason, that, unless attention is paid to subdividing the distance between two objects that appear almost in the same focus, it will be quite a difficult task to hit on the point that is in the true plane.

One will be greatly surprised, in carrying out the above experiment, at how deceptive the images of either cards containing printed matter, or two small holes through which illumination is thrown appear. They may seem to be relatively sharp in focus, one with the other, but when they are compared with a third card, or artificial star, placed between them, it is quite apparent that the outer cards or stars are not in the true focus.

In other words, in a lens of this great focal length, the approach toward the true point, as far as the eye is concerned, is quite gradual. Therefore, it can best be secured by continuing to subdivide the space between adjacent objects, as seen in the field of the telescope, until the true focal plane is obtained.

NAVAL OBSERVATORY,
Washington, D. C.

VARIATION OF LATITUDE.*

A notice of the book now before us, the first of a series which will contain the results of a most interesting and carefully planned astronomical enterprise, should certainly begin with some short account of the circumstances which led to its inception. It is impossible to say when the idea that the latitudes of places on the Earth are not constant first arose; the question treated dynamically is as old as the time of Euler, and there have been hints of periodic change of this kind in the records of several observatories; but it was in the years 1884 and 1885 that the subject first took definite shape in men's minds as a point for direct observation.

* 'Resultate des Internationalen Breitendienstes.' Band I. Von Th. Albrecht. Beriin, 1903.

Dr. Küstner, of the Berlin Observatory, and Dr. Chandler, of America, both have claims to be considered the originator. Dr. Küstner at this period was making observations by Talcott's method to determine the constant of aberration, and his observations showed discordances which he saw might very well be explained by an assumed change in the latitude of Berlin. Dr. Chandler was at this time making observations with his instrument, the almucantar, to detect changes in the latiude. At the meeting of the International Geodetic Association in 1888, Dr. Küstner's results were discussed, and though some eminent men put forward the view that these apparent variations had a meteorological origin, it was determined that the subject required investigation, that the Association therefore should make an attempt to solve the question by direct observation, and as a preliminary experiment, latitude should be determined by Talcott's method at Berlin, Potsdam, Prague, and Strasburg, from the beginning of the year 1889. Dr. Chandler at this time was investigating the matter by the re-reduction of old observations, and deduced from them the well known formulæ associated with his name, which show how the axis of rotation of the Earth moves with reference to the axis of figure. His classic series of papers on the subject will be found in the *Astronomical Journal* for 1893 and subsequent years. These results, and the fact that the observations made at the above-named observatories, and others which had joined in the work under the auspices of the International Geodetic Association, had furnished evident proof of sensible variations of the terrestrial axis, led Dr. Foerster, of Berlin, to make in 1895 a proposal that the work should be continued with the utmost possible refinement. He pointed out that the curve representing the motion of the pole was not a closed curve, that is, the movement was not periodic, and therefore six years was not sufficient in which to learn all the facts. This was the beginning of the enterprise now in hand. By the time of the meeting of the International Association at Stuttgart in 1898 preparations were well advanced, a special fund had been raised to meet the expenses of the work, and four stations had been chosen, all within a few seconds of arc in the same parallel of latitude, which was an essential of the plan, and widely different in longitude. At these four places—Carloforte, in the island of San Pietro, close to Sardinia, latitude 39° 8′ 12″, longitude 33^m 15^s E.; Mizusawa, in Japan, latitude 39° 8′ 0″, longitude 9^h 24^m 30^s E.; Gaithersburg, Maryland, about 30 miles northwest of Washington, latitude 39° 8′ 10″, longitude 5^h 8^m 48^s W.; and

Ukiah, California, latitude 39° 8′ 12″, longitude $8^h\ 12^m\ 52^s$ W.,—special observatories had been built or were in process of building, and four zenith telescopes had been ordered; also offers had been received and accepted from Russia to establish an Observatory at Tschardjui in Russian Asia, latitude 39° 8′ 10″, longitude $4^h\ 14^m$ E., and from the already established Observatory at Cincinnati, latitude 39° 8′ 20″, longitude $5^h\ 38^m$ W., to join in the work. The first four observatories are supported wholly from the fund raised by the Association, except that the observer at Gaithersburg is an officer of the U. S. Coast Survey. The two observatories last mentioned receive subsidies from the same fund.

Observations at these six places were begun in the autumn of 1899, and the volume now published contains the reduction of these observations made to the end of 1901. It is not difficult to describe briefly its contents. Talcott's method consists in measuring the zenith-distance of two stars which are at small and approximately equal distances from the zenith. The zenith-point is defined by means of observations of a level, so that the level is an important part of the equipment. The two stars being at equal zenith-distances, if the refraction follows the same law north and south of the zenith, its effect is eliminated in the mean, and each pair of stars gives a value of the latitude computed from the known declinations of the stars. The first table of results in this book (excluding the preliminary determination of screw-value and instrumental constants) gives the latitude as determined from each pair of stars; the range of the values deduced from a pair of stars appears to be 0″.3, the difference between those given by different pairs is somewhat larger than this. These values of latitude are then collected to give a value of the latitude for each night, the observations at each station, of course, being tabulated separately, and these values are again grouped to show the latitude of each station as determined month by month. This practically proves the question, for the variation at each station is apparent, and when the values are plotted and a smooth curve drawn, the individual results agree remarkably well with it, the discordances being in very few cases greater than 0″.03, and roughly speaking, the curves for western stations are the inverse of those for the eastern. Finally, the results for the different stations are discussed together to find the motion of the pole that fits them best. First, the formula

$$\phi - \phi_0 = x \cos l + y \sin l$$

is tried, and then another hypothesis; but finally the formula

$$\phi - \phi_0 = x \cos l + y \sin l + z$$

(which is the first with the inclusion of the quantity which has come to be called the "Kimura"-term, from the astronomer who first detected it) is found to give the smallest residuals, and this solution may be taken as the result of this section of the work. In the year 1900 the pole moved about its mean position practically in a circle of diameter about 0″.1; in 1901 its path opened out and ranged over a distance of about 0″.2 in each direction; and from *A. N.* 3875, in which results more recent than those in this book are given, it appears that in 1892 the pole moved in an approximately circular curve of still larger radius. The curves which represent the "Kimura"-term, which has been suggested as having a physical cause in an annual oscillation of the center of gravity of the Earth, are remarkably accordant for the six stations, so that the effect can hardly be supposed to be caused by meteorological circumstances, which would be different in such widely different longitudes. We congratulate Professor Albrecht and all concerned on this excellent and interesting work.—*The Observatory, London, August, 1903.*

INTENSITY OF SPECTRAL LINES.

EDWARD C. PICKERING.

For many years it has seemed to me that the determination of the intensity of the lines in the spectrum would be an investigation of great value. When Professor Rowland was planning his standard catalogue of lines in the solar spectrum, he consulted me regarding the advisability of giving their intensities as well as their positions. My reply was that the intensities were as important as in the case of stars, and that a whole science like that of stellar photometry and stellar variability might thus be developed.

The problem of determining the absolute intensity of spectral lines is one of great difficulty, but finding their relative intensities appears to be comparatively easy. In the case of bright lines, the relative intensities of adjacent lines may be found by the bolometer or similar instrument, or by a comparison of photographs, as described below. The comparison of dark lines on a light background, although apparently more difficult, has one great advantage, the background furnishes a convenient stand-

ard unit. We may call the intensity of a dark line unity if the light cut off from the background is equal to that of one ten-millionth of a millimetre, or one Ångström unit. This definition serves to compare lines which are broad or narrow, hazy or well defined. Two methods may be employed for the comparison. First, the selection of a sequence of standard lines whose intensity may be determined once for all, and the comparison of all others with them. Secondly, the construction of a standard scale with which each line may be compared directly. The second method has been employed here, since it promises to give approximate absolute values. The construction of the scale was entrusted to Mr. Edward S. King. A drawing was first made of a series of lines whose widths were proportional to 1, 2, 3, 4, etc., forming an arithmetical progression, and a reduced photograph was made of it. In this scale, the interval between 1 and 2 appeared much larger and was more easily subdivided than the higher intervals, some of which showed scarcely any difference. As in almost all physiological sensations, equal differences correspond to geometrical, rather than to arithmetical, differences. A second scale was accordingly constructed, each line being about 1.26 as wide as that next it, so that the logarithms of their widths would differ by 0.1. This scale was then reduced rather more than twenty times. Prints were made from it, but were found to give images much more sharply defined than the lines in actual spectra. This was remedied by inserting one or more pieces of paper between the negative and sensitive paper in making the prints, and lines were thus obtained having any desired degree of haziness. The lines in Rowland's maps of the Solar Spectrum were found to be too hazy, and to differ too much in different portions of the same map, for satisfactory comparison. This difficulty was remedied by using the maps of Higgs. The Frauenhofer line E was selected, partly because it contained numerous lines of varying intensity well adapted to measurement, and partly because it was made the subject of special study by the writer in 1875 (Proc. Amer. Acad. XI. p. 273).

The line E appears on five of Higgs' Charts, Nos, 2, 3, 75, 76 and 79. The first two are taken from spectra of the second order, and on them one Ångström unit equals 0.14 cm. In the other three, taken from spectra of the third order, one unit equals 0.21 cm. We might expect that the linear width of the lines would be in the same proportion, but this is not the case. Owing to photographic irradiation, or other causes, the measured

intensity of the lines is nearly the same in all. Although this shows that large errors may occur in the absolute intensity of the lines, it will not affect the relative intensity. A curve has been constructed for converting the scale measures into linear dimensions, assuming that the mean of the results derived from the two dispersions is the true value.

The results of these measures are given in Table I. The wavelength, according to Higgs, is given in the first column. This does not appear to differ by a tenth of a unit on his different maps. The original measures on the five maps are given in the second column. Italics denote that when making the original measure the line was overlooked, but was found on reëxamination, when its existence on the other maps was known. The mean of the readings, and residuals from the mean are given in the third and fourth columns. The fifth column gives the concluded equivalent width of the line, in Ångström units, found graphically as described above. The sixth column gives the results of the comparison made in 1875, mentioned above. The dots indicate lines given by Kirchhoff, Angström, Sharpless, Amory, Pickering and Young, respectively.

A few additional lines were seen by some of the six observers mentioned above, so that the total numbers given by them, including those that are doubtful, are 12, 11, 32, 22, 30 and 37, respectively. The corresponding widths of the faintest lines given are .064, .080, .012, .022, .014, and .009. The 36 lines in Table I correspond to a width of .009. Rowland's first map of the Solar Spectrum shows about 30 lines, the second edition 33 lines. The corresponding widths are .013 and .011.

TABLE I.

INTENSITY OF SPECTRAL LINES.

λ	Readings.					Mean.	Residuals.	Width.	Lines.
5261.8	9.4	9.5	9.5	9.6	9.5	9.50	*1*0010	.105	.....
2.1	8.5	8.6	8.5	8.6	8.5	8.54	01010	.010	
2.3	..	..	8.7	8.8	8.7	8.73	010	.016	
2.4	9.6	9.6	9.5	9.6	9.4	9.54	11011	.114	. ....
2.7	8.7	8.8	8.6	8.6	8.6	8.66	01*111*	.013	?...
3.1	8.8	8.9	8.8	8.7	8.7	8.78	010*11*	.018	.
3.5	9.5	9.6	9.5	9.6	9.6	9.56	*1*0*1*00	.119	.....
4.0	9.0	9.2	9.0	9.0	9.0	9.04	02000	.038	....
4.3	9.7	9 7	9.8	9.8	9.8	9.76	*11*000	.201	.....
5.0	9.1	9.2	9.1	9.1	9.0	9.10	0100*1*	.045	....
5.4	8.9	9.0	8.8	8.8	8.8	8.86	01*111*	.022	. ..
5.6	9.4	9.5	9.5	9.6	9.6	9.52	*1*0011	.109	.....
5.8	9.2	9.3	9.2	9.4	9.3	9.28	*1*0*1*10	.064	. ..
6.2	8.9	9.1	8.9	9.0	8.9	8.96	*11101*	.030	..?
6.5	*8.5*	8.7	*8.6*	8.6	*8.5*	8.58	*11001*	.010	..
6.7	9.6	9.7	9.6	9.8	9.8	9.70	*1*0*1*11	.177	.....
7.4	8.8	9.0	8.8	9.0	8.8	8.88	*11111*	.022	.

TABLE I.—CONTINUED.

λ	Readings.					Mean.	Residuals.	Width.	Lines.
5268.5	8.9	9.1	9.0	9.0	8.9	8.98	*11001*	.032	....
8.8	8.8	8.6	8.8	8.8	8.8	8.76	02000	.017	.
9.2	*8.6*	*8.7*	*8.6*	*8.5*	8.5	8.58	0101*1*	.010	. ..
9.7	9.8	9.9	9.8	9.9	9.9	9.86	*10*100	.245	.....
5270.5	9.8	9.8	9.9	10.0	9.9	9.88	*11*010	.256	.....
1.2	8.8	9.2	8.8	8.9	8.8	8.90	13*10*1	.023	....
1.4	8.7	9.0	8.7	8.8	8.7	8.78	12*10*1	.018	. ..
2.1	8.8	9.1	8.8	8.9	8.8	8.88	12*10*1	.022	....
2.4	8.6	8.9	8.6	8.7	8.6	8.68	12*10*1	.014	. ..
2.5	..	8.8	..	8.6	8.5	8.63	.2.0*1*	.012	
3.3	9.4	9.5	9.4	9.6	9.5	9.48	*10*110	.100	. ..
3.5	9.4	9.5	9.4	9.6	9.5	9.48	*10*110	.100	.....
4.4	8.5	8.6	8.6	8.5	8.6	8.56	*10*010	.010	.
4.7	8.6	8.7	8.7	8.7	8.5	8.68	10000	.014	....
5.1	9.0	9.2	9.2	9.0	9.0	9.08	*11111*	.042	. ..
5.3	8.7	8.8	8.8	8.8	8.7	8.76	*10001*	.017	
5.4	9.0	9.2	9.2	9.1	9.0	9.10	*11101*	.045	.....
5.9	9.1	9.3	9.3	9.1	9.1	9.18	*11111*	.049	. ..
6.2	9.5	9.6	9.6	9.6	9.6	9.58	*10*000	.123	.....

In all these cases only lines clearly seen are included. It is surprising how slight has been the gain during the last quarter of a century when we consider that it includes the invention of the concave grating. Nearly as faint lines were shown with a prism spectroscope in 1875, as can now be clearly seen in the best maps of the spectrum. Fainter lines are shown in the original negatives. Thus, Rowland's Catalogue of Wave-Lengths contains 69 lines in this region. The average of the residuals in the fourth column is ± .06.

HARVARD COLLEGE OBSERVATORY,
Circular No. 72, July 29, 1903.

PLANET NOTES FOR SEPTEMBER AND OCTOBER.

H. C. WILSON.

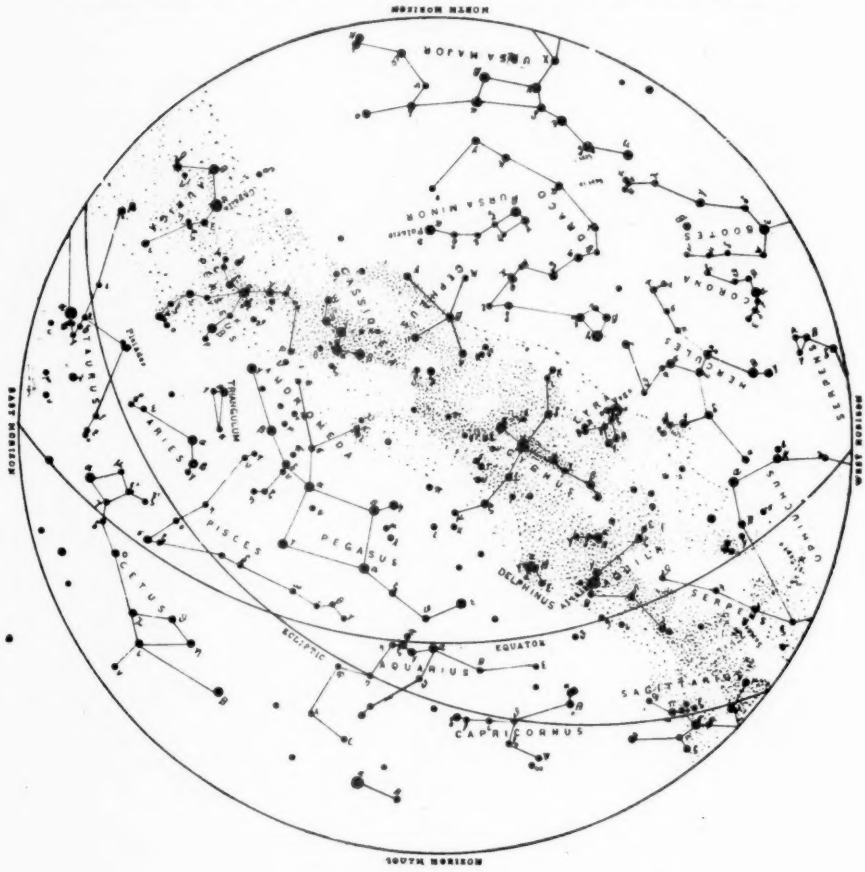
Mercury will be visible as evening star during the first half of September, reaching greatest elongation, east from the Sun 27°, on Sept. 7. On Oct. 3 the the planet will come to inferior conjunction and during the middle of that month it will be visible again as morning star.

Venus has now about disappeared as evening star in the glare of the early twilight and will be at inferior conjunction Sept. 17. She will emerge from the morning twilight about the end of the month and be visible as morning star for several months to come. Her greatest brilliancy as morning star will be attained on October 24.

Mars is evening star setting in the southwest too soon after sunset for observations of any value. A very interesting account is given in *Monthly Notices* for June 1903, by Messrs. Evans and Maunder, of a series of "Experiments as to the Actuality of the Canals observed on Mars." The conclusions drawn from the experiments are stated in these words: "Markings having all the characteristics

of the canals of Mars can be seen by perfectly unbiased and keen-sighted observers upon objects where no marking of such a character actually exists. They are in a sense truly 'seen,' not imagined, because they are the natural rendering by the eye of real markings of a different character."

Jupiter will be at opposition Sept. 11 and so may be observed during the greater past of the night. In the early evening the planet is the most conspicuous



THE CONSTELLATIONS AT 9 P. M. OCTOBER 1, 1903.

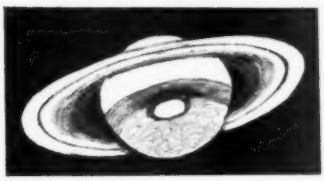
star seen toward the east. His course is southwestward in the constellation Aquarius.

Saturn is in Capricorn, seen toward the south as soon as twilight darkens. The planet will be at quadrature, 90° east from the Sun, Oct. 27. The ring system is turned well up, its plane making an angle of 20° with the line of sight, so that the details of structure may be easily seen in moments of good definition.

Unfortunately the latter are rare because of the low altitude of the planet, but by patient watchlng one wili now and then be rewarded by a splendid view.

On the morning of June 16 at 3 A. M. Professor Barnard, examining Saturn with the 40-inch telescope of Yerkes Observatory, noticed a decided bright spot on the planet, half way from the central meridian to the following limb. The sky immediately clouded over, and no opportunity to observe the spot again occurred until the morning of June 24 when Professor Barnard noted its transit across the central meridian of the planet at $3^h\ 42^m$ A. M., Central Standard Time. He again noted a transit on the morning of June 25 at $12^h\ 58^m$ A. M., C. S. T.

At Goodsell Observatory the spot was seen in transit on the morning of July 2 at $3^h\ 18^m$ A. M., C. S. T. It was easily seen, oval in shape, lying just north of the dusky belt north of Saturn's equator. Micrometric measures gave for its length 3″.93, and its width 2″.36; for the distance of its center north of the planet's disc 2″.04 and for the polar diameter of the planet 18″.48. The spot appeared to be surrounded by a narrow dusky line, which may have been simply effect of contrast.



BARNARD'S WHITE SPOT ON SATURN AS OBSERVED BY H. C. WILSON, JULY 1, 1903, 21 HRS. 18 MIN., GR. M. T.

From the above observations the period of rotation of Saturn appears to be about $10^h\ 39^m$, or nearly 25 minutes greater than the period determined by Professor Hall in 1876, from observations of an equatorial white spot.

Uranus will be at quadrature, 90° east from the Sun, Sept. 15, and is too low in the southeast at twilight to be well seen. Uranus and Mars will be in conjunction Oct. 24 at 9 A. M., when the two planets will be a little over a degree apart in declination.

Neptune will be at quadrature, 90° west from the Sun, Sept. 29, and may be observed in the early morning hours. He is to be found near the star μ at the foot of Gemini but is invisible without a telescope.

Sunspots have been quite numerous during the past two months, as many as five groups and thirty to forty spots being visible at once on a few of the days. All of the spots were comparatively small.

The Moon.

	Phases.		Rises. (Central Standard Time at Northfield Local Time 13m less.)		Sets.	
			h	m	h	m
Sept.	6-7	Full Moon	6	27 P. M.	6	17 A. M.
	13-14	Last Quarter	10	30 "	1	34 P. M.
	20	New Moon	5	14 A. M.	5	59 "
	28	First Quarter	1	34 P. M.	11	22 "
Oct.	6-7	Full Moon	5	56 "	7	14 A. M.
	12-13	Last Quarter	10	18 "	1	17 P. M.
	20	New Moon	6	27 A. M.	5	37 "
	28	First Quarter.	1	27 P. M.	11	57 "

Occultations Visible at Washington.

Date. 1903.	Star's Name.	Magnitude.	IMMERSION. Washington M.T. h	m	Angle from N pt. °	EMERSION. Washington M. T. h	m	Angle from N pt. °	Duration. h	m
Sept. 5	ρ Aquarii	5.4	9	54	39	11	15	271	1	21
6	B.A.C. 8017	6.1	6	12	50	7	10	276	0	58
6	B.A.C. 8094	5.6	16	14	135	16	40	180	0	26

Occultations Visible at Washington.—Continued.

Date. 1903.	Star's Name.	Magnitude.	IMMERSION. Washington M.T. h m	IMMERSION. Angle from N pt. °	EMERSION. Washington M. T. h m	EMERSION. Angle from N pt. °	Duration. h m
9	96 Piscium	6.6	9 01	10	9 32	0	0 31
12	55 Tauri	7.3	15 30	82	16 54	253	1 24
12	63 Tauri	5.6	17 50	62	19 08	283	1 18
15	λ Geminorum	3.6	16 02	112	17 10	254	1 08
27	B.A.C. 6060	6.5	7 21	45	8 26	304	1 05
Oct. 2	36 Aquarii	6.3	13 46	13	14 24	303	0 38
3	B.A.C. 7986	5.8	12 26	72	13 42	238	1 16
3	B.A.C. 7993	6.6	13 51	89	14 55	227	1 04
5	44 Piscium	5.8	8 17	116	9 06	194	0 49
6	96 Piscium	6.6	17 53	115	18 38	215	*0 45
10	B.A.C. 1526	5.8	12 12	118	13 09	219	0 57
15	11 Sextantis	6.0	17 18	134	18 25	264	1 07
25	B.A.C. 6287	6.0	8 21	105	9 22	234	1 01
25	B.A.C. 6294	5.2	9 12	41	10 01	299	0 49
28	8 Aquarii	6.8	9 39	39	10 48	268	1 09
31	B.A.C. 8094	5.6	5 30	28	6 36	285	1 06

COMET AND ASTEROID NOTES.

New Comet *c* 1903 (Borrelly).—A new comet was discovered by Bor elly of Marseilles, France, shortly before midnight on the night of June 21, in the constellation Aquarius. It was then a conspicuous telescopic object and increased rapidly in brightness, becoming visible to the naked eye in July and exhibiting a tail which could be traced for three or four degrees with the aid of field-glasses. During the summer the comet has swept nearly half way across the heavens in its movement toward the Sun and is now (Aug. 20) to be found toward the northwest in the early evening, in the constellation Leo Minor (just south of the Great Bear). During September it will pass southward through Leo, Sextans and Hydra.

It was nearest the Earth July 15, and brightest to the naked eye a few days later, although it does not reach perihelion until August 27. The accompanying diagram shows its actual path in relation to that of the Earth. An inspection of this diagram shows at a glance why the comet was so easily seen in July and now is becoming fainter although much nearer perihelion. The plane of the comet's orbit is very nearly perpendicular to that of the Earth and the comet had just passed its ascending node when it was discovered. It was then rapidly approaching the Earth, but its path was inclined at such angle that it passed over the Earth at a distance of about 25,000,000 miles. In September it will again descend to the south side of the Earth's orbit and will also be on the farther side of the Sun, so that it will be invisible until toward the end of the month. Later on it will be seen only in the southern heavens and at such a great distance as to make it a faint object even in the telescope.

Photographs of the comet were taken at Goodsell Observatory on the nights of July 20, 21, 22 and 23, with the 8-inch Clark refractor, the 6-inch Brashear star camera and the 2½ inch Darlot lens. On all the photographs the tail of the comet is very much fainter than the head and much narrower as it emerges from the coma. On all those taken with the two smaller lenses the tail divides into three or more branches and changes in details of structure from night to night. On that taken with the Darlot lens July 22, with an exposure of $2^h\ 30^m$ one of

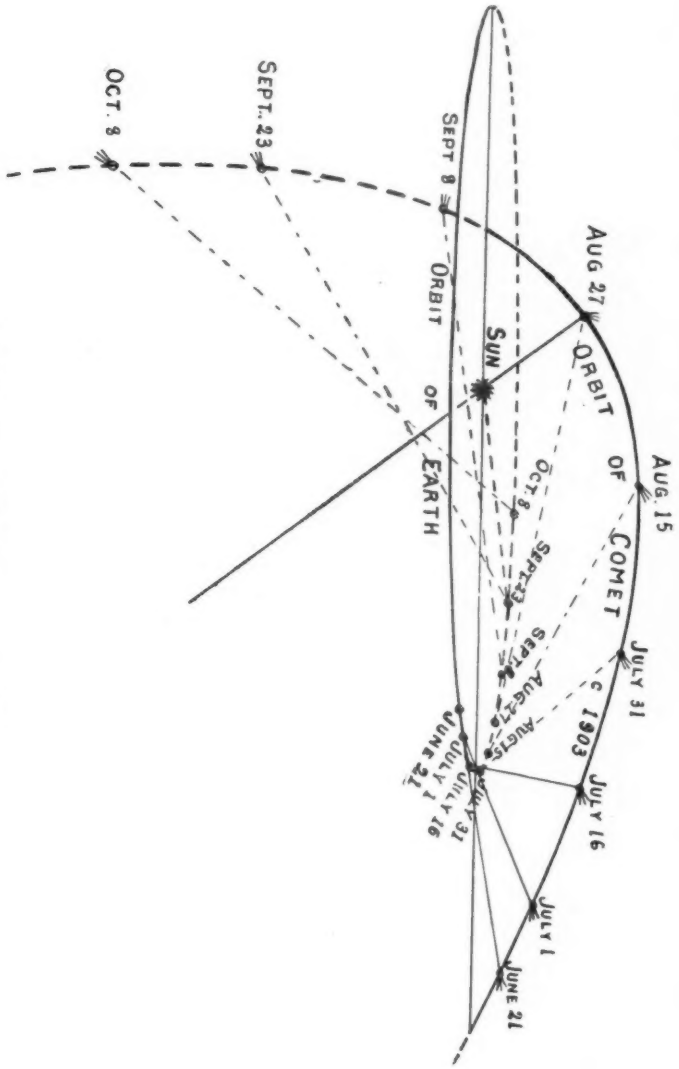


Diagram of the Orbit of Comet c, 1903.

the branches extends to the edge of the plate, *i. e.*, about 13° from the head of the comet. At about 5° from the head one can count five divisions of the tail and two others are seen to emerge but a little way from the coma.

Elements and Ephemeris of Comet *c*, 1903 (Borrelly).—The following system of elements is based on the observations of June 22, June 30 and July 10, by Dr. Aitken:

$T = 1903$, August 27.6056 Greenwich M. T.
$\omega = 127°\ 19'\ 25''.5$
$\Omega = 293\ \ 32\ \ 55\ .0$ } 1903.0
$i = \ 84\ \ 59\ \ 45\ .3$
$q = 9.518126$

Residuals.	(O − C)
$\Delta\lambda' \cos\beta'$	− 1″.0
$\Delta\beta'$	+ 5 .7

CONSTANTS FOR THE EQUATOR OF 1903.0.

$x = r\,[9.610075] \sin(206°\ \ 0'\ \ 21''.2 + v)$
$y = r\,[9.962172] \sin(\ 13\ \ 53\ \ 30\ .3 + v)$
$z = r\,[9.998662] \sin(105\ \ 51\ \ 25\ .5 + v)$

EPHEMERIS FOR GREENWICH MEAN MIDNIGHT.

1903.	True α. h m s	True δ. ° ′	log Δ	Br.
July 14.5	20 4 52	+ 48 30.3	9.430	12.9
16.5	19 14 28	58 7.7	9.427	14.1
18.5	17 55 38	65 28.9	9.442	14.1
20.5	16 10 57	68 39.8	9.472	13.3
22.5	14 34 11	67 38.7	9.512	12.0
24.5	13 27 36	64 27.6	9.556	10.6
26.5	12 45 22	60 45.6	9.601	9.4
28.5	12 17 36	57 14.5	9.644	8.3
30.5	11 58 12	54 5.4	9.687	7.7
Aug. 1.5	11 43 44	51 18.8	9.726	7.1
3.5	11 32 21	48 51.6	9.764	6.7
5.5	11 22 50	46 40.4		
7.5	11 14 49	44 41.2	9.832	6.3
9.5	11 7 31	42 50.8		
11.5	11 0 49	41 6.3	9.893	6.3
13.5	10 54 23	39 24.1		
15.5	10 48 12	37 42.9	9.947	6.7
17.5	10 42 2	35 58.0		
19.5	10 35 58	34 7.2	9.996	7.4
21.5	10 29 54	32 7.0		
23.5	10 24 3	29 54.8	0.038	8.2
25.5	10 18 30	27 27.0		
27.5	10 13 31	24 47.3	0.074	7.9
29.5	10 9 20	21 54.6		
31.5	10 5 59	18 53.8	0.100	6.2
Sept. 2.5	10 3 36	15 49.9		
4.5	10 2 1	12 45.1	0.118	4.3
6.5	10 1 8	9 43.1		
8.5	10 0 50	6 45.1	0.132	2.9
10.5	10 1 2	3 50.8		
12.5	10 1 37	+ 1 2.4	0.142	2.0
14.5	10 2 27	− 1 42.8		
16.5	10 3 35	4 21.9	0.152	1.5
18.5	10 4 52	6 58.7		
20.5	10 6 19	− 9 29.5	0.161	1.1

The unit of brightness is that at the time of observation on June 22.

C. D. PERRINE.

Lick Observatory Bulletin, No. 47,
July 14, 1903.

Ephemeris of Comet *c*, 1903.

[From A. N. 3890. Computed by Messrs. Knapp and Dziewulski of Gottingen.]

Berlin Midn. 1903		R. A. h	m	s	Decl. °	′	″	log *r*	log Δ	Brightness.
Aug.	28	10	11	18	+ 23	24	28	9.5191	0.0807	7.8
	30		7	31	20	27	5	9.5319	0.0938	7.0
Sept.	1		4	39	17	23	52	9.5560	0.1048	5.9
	3		2	39	14	18	56	9.5874	0.1140	4.9
	5		1	27	11	15	22	9.6225	0.1218	4.0
	7		0	53	8	14	59	9.6588	0.1285	3.3
	9		0	51	5	18	43	9.6945	0.1344	2.7
	11		1	15	+ 2	27	15	9.7288	0.1397	2.3
	13		1	58	− 0	19	16	9.7613	0.1447	1.9
	15		2	57	3	1	54	9.7919	0.1493	1.6
	17		4	10	5	39	51	9.8207	0.1538	1.4
	19		5	33	8	13	41	9.8476	0.1582	1.2
	21		7	4	10	43	38	9.8729	0.1626	1.0
	23		8	42	13	9	52	9.8966	0.1669	0.9
	25		10	26	15	32	33	9.9190	0.1713	0.8
	27		12	14	17	51	51	9.9401	0.1756	0.7
	29		14	5	20	8	3	9.9600	0.1800	0.6
Oct.	1		16	0	22	21	5	9.9789	0.1845	0.6
	3		17	56	24	31	15	9.9968	0.1891	0.5
	5		19	54	26	38	32	0.0139	0.1937	0.5
	7		21	54	28	43	6	0.0301	0.1984	0.4
	9		23	53	30	45	1	0.0456	0.2031	0.4
	11	10	25	56	− 32	44	23	0.0604	0.2080	0.4

Photographs of the Region of Borrelly's Comet *c*, 1903, were taken at the Harvard College Observatory on May 28, 1903, at $19^h\ 48^m$ G. M. T. and May 30, at $19^h\ 52^m$ G. M. T., about three weeks before its discovery. The positions of the comet at these times were for 1855, R. A. $21^h\ 49^m\ 27^s$, Decl. $-19°\ 6'.1$ and R. A. $21^h\ 50^m\ 15^s$, Decl. $-18°\ 33'.2$ according to the ephemeris of Fayet, *Astron. Nach.* 162, 291. In both cases the position of the comet was near the edge of the plate. An object closely resembling the comet was found on the first plate in R. A. $21^h\ 48^m\ 43^s$, Decl. $-19°\ 16'.8$ and of about the magnitude of the stars $-19°6193$ and $-19°6198$.

These stars appeared on the second plate but no image of the comet was found in the corresponding position. Its computed brightness on these dates should have been about one-sixth of that at the time of discovery. It was therefore probably too faint to appear on these plates but that cannot be determined with certainty until more accurate elements have been computed. Plates covering the region of the comet were also obtained at Arequipa on May 14 and May 29, and probably on May 4, 1903, but they have not yet been received in Cambridge.

EDWARD C. PICKERING.

HARVARD COLLEGE OBSERVATORY,
Astronomical Bulletin, July 21, 1903.

The Spectrum of Comet Borrelly Obtained with the Crossley Reflector.—A spectrum of Comet Borrelly was obtained with the small slit spectrograph on July 15th, with an exposure of four hours. The five bands are shown which were photographed by Campbell in Comet *b* 1893 (Rordame)* and in Comet *b* 1894 (Gale)†.

* *Astronomy and Astro-Physics*, Vol. XII, p. 652.

† *Astronomical Journal*, Vol. XIV, p. 111.

The relative intensities of these bands in the spectrum of Comet Borrelly appear to be the same as in the two earlier comets, after making allowance for the differences in dispersion and absorption of the two instruments, with the exception of the band at λ 420. Although this band is one of the strongest in both of the earlier comets it is extremely weak in Comet Borrelly.

The brighter of the bands show evidence of their composite character, although they are not resolved.

Very little continuous spectrum is shown by the photograph.

C. D. PERRINE.

Lick Observatory Bulletin, No. 47,
July 16, 1903.

Observation of the Spectrum of Comet Borrelly made with the Thirty-Six Inch Refractor.—The spectrum of the Comet Borrelly was observed on July 14 and 15 with spectrograph I (cf. L. O. *Bulletin*, No. 8). Visually it showed a relatively strong continuous spectrum and three characteristic bands. Of these that at λ 4700 seemed the brightest, while the other two were much fainter.

The attempt was made to secure a photograph of the spectrum with an exposure of six hours, using the same instrument, but the intrinsic brightness of the comet is quite small, and only the merest trace shows on the plate in the region near λ 4700.

H. D. CURTIS.

Lick Observatory Bulletin, No. 47,
July 17, 1903.

Preliminary Note on Photographic Observations of Comet *c* 1903 (Borrelly).—Photographic observations of Comet *c* 1903 (Borrelly), were begun at the Lick Observatory on the night succeeding that of discovery, and are still in progress. Nine exposures ranging in length from thirty-eight minutes to four hours have been made with the Dallmeyer camera of 15 cm. aperture, 82.6 cm. equivalent focal length, and 14°x16° angular field. Three negatives with the same range of exposure have been obtained simultaneously with the Floyd camera of 13 cm. aperture and 178 cm. focal length.

Two tails one of which is nearly straight, the other greatly curved, appear on all but the last plate. The curved tail is short and very bright while the straighter tail is relatively fainter and longer but developes some very interesting forms.

On a plate of four hours' exposure on June 23d, the tails are widely separated. The straight tail is narrow at the head, but broadens and extends 1½ degrees. On the plate of June 29th the longer tail has split up into two distinct branches which emerge separately from the head and diverge slightly as they extend into space. With four hours exposure on June 30th the secondary tail appears very bright with a length of 1½ degrees. The primary extends five degrees from the nucleus. The form is indistinct, but the division of the previous night still persists. One branch remains straight while the other is broader and longer and follows a sinuous curve. On the following night the straight tail is sharp and single.

The plates of July 12th and 13th still show two tails. The primary tail is straight and narrow and the secondary tail still greatly curved. On the plate of July 12th, with 38 min. exposure, the primary tail is four degrees long; the second-

ary tail is 1.5 degrees in length. The plate of July 14th, $1^h\,48^m$ exposure, shows one straight narrow tail, 8½ degrees in length, widening out slightly as it extends away from the head.

On all the plates the nucleus is sharp aud approximately central with respect to the heavy coma.

During these exposures the Earth has been approaching rapidly to the plane of the comet's orbit. At the same time the apparent angle between the tails has steadily diminished until, on the plate of July 14th, they are coincident.

R. H. CURTIS,
SEBASTIAN ALBRECHT.

Lick Observatory Bulletin, No. 47.
July 15, 1903.

Search Ephemeris for Comet 1896 V (Giacobini.)—In *A. N.* 3881 Mr. M. Ebell gives an ephemeris extending from June 22 to Sept. 26. The portion for September is here given. It will be noticed that during September the comet will be somewhere along a line running nearly east and west, about 10° south of the Pleiades. It was quite faint in 1896 and as the limits of search given are wide (about 16° in right ascension) there may be some difficulty in finding it.

Berlin M. T.	Assumed Per. Pass. June 6.5		Assumed Per. Pass. June 22.5		Assumed Per. Pass. July 8.5.	
	α	δ	α	δ	α	δ
	h m s	° ′	h m s	° ′	h m s	° ′
Sept. 2	4 13 30	+17 7.7	3 43 15	+17 33.2	3 2 55	+17 56.2
6			3 48 32	+17 7.4		
10	4 23 42	+16 19.6	3 53 10	+16 38.3	3 12 11	+16 49.6
14			3 57 8	+16 6.0		
18	4 31 30	+15 21.7	4 0 23	+15 30.8	3 18 18	+15 25.7
22			4 2 55	+14 52.8		
26	4 36 44	+14 15.4	4 4 43	+14 12.2	3 21 24	+13 47.4

Rediscovery of Brooks' Periodic Comet 1881 V.—A telegram from Lick Observatory announces that Brooks' Periodic Comet was observed by Aitken

Aug. 18.8500 Gr. M. T. in R. A. $21^h\ 02^m\ 51^s.3$; Decl. $-27°\ 04'\ 19''$.

This makes the correction to Mr. Neugebauer's ephemeris, given in our last number and continued in this, only $+45^s$ in R. A. and $+1'\,40''$ in Decl., so that it is sufficiently exact for finding purposes. The comet is exceedingly faint and may not be seen with small instruments.

Ephemeris of Brooks Comet for the Return 1903-04.

[Computed by P. Neugebauer, A. N. 3868. Continued from p. 349.]

Berlin Midn. 1903.	R. A.	Decl.	log r	log Δ
	h m s	° ′ ″		
Sept. 1	20 53 36.06	−26 50 29.8		
2	53 6.98	26 47 53.8		
3	52 39.58	26 45 6.1		
4	52 13.90	26 42 6.8	0.3234	0.07693
5	51 50.03	26 38 55.9		
6	51 27.98	26 35 33.6		
7	51 7.78	26 32 0.0		
8	50 49.45	26 28 15.2	0.3210	0.08165
9	20 50 33.05	−26 24 19.4		

EPHEMERIS OF BROOKS COMET FOR THE RETURN 1903-04.—Continued.

Berlin Midn. 1903.	R. A. h	m	s	Decl. °	′	″	log *r*	log Δ
Sept. 10	20	50	18.61	−26	20	12.8		
11		50	6.14	26	15	55.5		
12		49	55.67	26	11	27.7	0.3187	0.08727
13		49	47.24	26	6	49.5		
14		49	40.87	26	2	1.0		
15		49	36.56	25	57	2.4		
16		49	34.32	25	51	53.8	0.3164	0.09369
17		49	34.19	25	46	35.2		
18		49	36.19	25	41	7.0		
19		49	40.31	25	35	29.2		
20		49	46.55	25	29	41.9	0.3142	0.10081
21		49	54.94	25	23	45.5		
22		50	5.49	25	17	40.0		
23		50	18.19	25	11	25.6		
24		50	33.02	25	5	2.4	0.3121	0.10853
25		50	49.97	24	58	30.6		
26		51	9.03	24	51	50.2		
27		51	30.20	24	45	1.4		
28		51	53.46	24	38	4.6	0.3101	0.11676
29		52	18.80	24	30	59.8		
30		52	46.18	24	23	47.1		
Oct. 1		53	15.60	24	16	26.7		
2		53	47.03	24	8	58.6	0.3081	0.12538
3		54	20.45	24	1	22.9		
4		54	55.85	23	53	39.9		
5		55	33.19	23	45	49.6		
6		56	12.44	23	37	52.0	0 3063	0.13432
7		56	53.58	23	29	47.2		
8		57	36.60	23	21	35.4		
9		58	21.46	23	13	16.6		
10		59	8.14	23	4	50.8	0.3045	0.14352
11	20	59	56.63	22	56	18.1		
12	21	0	46.88	22	47	38.6		
13		1	38.89	22	38	52.3		
14		2	32.62	22	29	59.3	0.3029	0.15292
15		3	28.05	22	20	59.7		
16		4	25.16	22	11	53.4		
17		5	23.92	22	2	40.6		
18		6	24.32	21	53	21.3	0.3014	0.16246
19		7	26.32	21	43	55.5		
20		8	29.90	21	34	23.3		
21		9	35.02	21	24	44.7		
22		10	41.67	21	14	59.8	0.3000	0.17210
23		11	49.81	21	5	8.6		
24		12	59.41	20	55	11.2		
25		14	10.45	20	45	7.6		
26		15	22.89	20	34	57.8	0.2986	0.18179
27		16	36.70	20	24	41.9		
28		17	51.86	20	14	20.0		
29		19	8.33	20	3	52.1		
30		20	26.09	19	53	18.3	0.2975	0.19149
31	21	21	45.10	−19	42	38.5		

Elements of Asteroids.—In *A. N.* 3874 Dr. A. Berberich gives provisional elements of the following recently discovered asteroids: 1902 KX, 1903 LA, 1903 LB, 1903 LC, 1903 LF, 1903 LN. In *A. N.* 3876 Mr. H. Osten also gives elements of 1903 LC.

New Asteroids.—The following have been added to the list of minor planets since our last note:

Discovered By	At	Local M. T.	R. A.	Decl.	Mag.
		h m	h m	° ′	
1903 LS Wolf,	Heidelberg	April 20 9 24.0	7 11.0	+21 23	14
LT Dugan,	"	May 20 10 36.6	15 59.1	−10 10	12.3
LU Dugan,	"	May 30 10 41.6	16 52.3	− 9 13	10.5
LV Wolf,	"	June 23 12 11.2	17 51.7	−18 7	11.8
LW Wolf,	"	June 30 12 01.2	17 12.6	−17 25	12.0
LX Wolf,	"	July 1 12 08.2	17 58.8	−22 24	11.0

1903 LS was at first thought to be identical with 1902 KX but later observations disprove the identity.

Numbering of New Asteroids.—In *A. N.* 3888 Dr. J. Bauschinger assigns the following numbers to the minor planets, discovered during the past year, which were sufficiently observed to determine their orbits:

Number.	Provisional Designation.	Discovered.	Discoverer.	Name.
(488)	1902 JG	1902 June 26	Wolf	
(489)	" JO	Sept. 3	Wolf	
(490)	" JP	" 3	Wolf	
(491)	" JQ	" 3	Wolf	Carina
(492)	" JR	" 3	Wolf	
(493)	" JS	" 3	Wolf	
(494)	" JV	Oct. 7	Wolf	
(495)	" KG	" 25	Wolf	
(496)	" KH	" 25	Wolf	
(497)	" KJ	Nov. 4	Dugan	
(498)	" KU	Dec. 2	Charlois	
(499)	" KX	" 24	Wolf	
(500)	1903 LA	1903 Jan. 16	Wolf	
(501)	" LB	" 18	Wolf	
(502)	" LC	" 19	Wolf	
(503)	" LF	" 19	Dugan	
(504)	1902 LK	1902 June 30	Bailey	
(505)	" LL	Aug. 21	Frost	
(506)	1903 LN	1903 Feb. 17	Dugan	

VARIABLE STARS.

The Period of Variable 4.1903 Draconis (BD. + 73°533).—In *A. N.* 3888 Mr. S. Blajko gives the following elements of this Algol-type variable

Minimum = 1903, March 3 $9^h\ 34^m + 1^d\ 8^h\ 34^m\ 43^s$ E, Gr. M. T.

At normal brightness the variable is just about equal to the star BD. + 73°534 ($9\frac{4}{5}^m$); at minimum it is near 12.5 mag. It begins to decrease three hours before minimum and wanes slowly, but about 40 minutes before the minimum the brightness falls rapidly, losing a whole magnitude in 20 minutes; then for 38-40 minutes it remains stationary. The ascending and descending branches of the light curve appear to be symmetrical.

Elements of the Variable 10.1903 Lyræ.—In *A. N.* 3873 Dr. Hartwig gives the following formula for this variable:

Maximum = 1903 April 28 + 250^d E.

This depends upon photographic observations extending as far back as 1894.

New Variable Star 17.1903 Lyræ.—This was announced in *A. N.* 3870 by Mr. A. Stanley Williams. Its position is

R. A. = $18^h\ 39^m\ 37^s.5$; Decl. = + 34° 31′.4 (1855.0)

and it lies almost exactly midway between the two stars BD. + 34°3301 and 3303 (8.7 and 9.2 magnitude respectively). The observed range of variation is from 9.9^m to 12.3^m and the period is perhaps roughly 348 days. The next maximum should occur somewhere near Sept. 2, 1903.

The Period of the Variable 20.1902 Cygni.—In *A. N.* 3882 Mr. S. Blajko determines the following elements of this star making the period 1^d.477051:

Minimum = J. D. 2416074.164 + 1^d.477051E., Gr. M. T.

New Variables 20, 21 and 22.1903 Camelopardalis.—These are announced in *A. N.* 3877 and were discovered by Mme. Ceraski upon photographs taken by M. S. Blajko at Moscow. Their positions are as follows:

	R. A. 1855.0. h m	Decl. 1855.0. ° ′	R.A. 1900.0. h m	Decl. 1900.0. ° ′	Mag.
20.1903	6 5.8	+ 75 32	6 12.0	+ 75 32	10½ — 12
21.1903	7 21.5	+ 76 22.3	7 27.6	+ 76 16.9	9.5 — 11.5
22.1903	4 26.8	+ 74 50	4 32.6	+ 74 56	9 — 11

The star 21.1903 is BD + 76°286 and is probably an Algol-type variable.

Suspected Variables 23, 24, 25, 26, 27 and 28.1903.—In *A. N.* 3877 Mr. W. de Sitter gives a list of six suspected variables found in the course of the reductions of a great mass of photometric, visual and photographic observations, of which details are soon to be published in the publications of the Astronomical Laboratory at Groningen. Their positions are as follows:

	R. A. 1875.0. h m s	Decl. 1875.0. ° ′	Mag.
23.1903 Sculptoris	1 21 22	— 33 33.4	9.7 — < 11
24.1903 Canis Majoris	7 16 16.0	— 25 12.7	8.7 — 11
25.1903 Puppis	8 20 54.8|	— 39 37.6|	10 — 11
	56.8|	37.9|	9 — 11
26.1903 Normae	16 23 49.2	— 46 40.0	8.8 — 10
27.1903 Sagittarii	17 46 41.9	— 24 48.9	9.3 — 10.2
28.1903 Ceti	23 53 10	— 25 7.5	9.8 — < 11

New Variable 29.1903 Herculis.—In *A. N.* 3883 Messrs. Müller and Kempf, of Potsdam, Germany, announce that the star BD. + 48°2334 varies between the limits 7.4^m and 8.1^m. Its period appears to be several months. A minimum occurred in the latter half of March and a maximum about the end of April. The rise to maximum seems quicker than the fall to minimum.

New Variable 30.1903 Sagittarii.—This is announced in *A. N.* 3890 by Professor M. Wolf, of Heidelberg, and is situated in the nebula Messier 8 (N. G. C. 6523), on the edge of a dark channel. Its position for 1875.0 is

R. A. 17^h 55^m 39^s.35; Decl. — 24° 29′ 46″.0.

The observed range of variation upon seven photographs is from 11.2 to <13 magnitude.

The Variable Star 6871 V Lyræ.—In the *Astrophysical Journal* for July 1903 Mr. J. A. Parkhurst gives a determination of the light-curve and period of this star from all of the available observations. The star was discovered by Anderson in 1895 and has passed seven maxima since that time. Mr. Parkhurst

find the period to be 377 days and the range of variation from between 9^m and 10^m at maximum to about 15^m at minimum. Maxima may be predicted by the following formula:

Maximum = 1893 Aug. 11 (J.D. 2412687) + 377E.

The Light Curve of β Lyræ.—In *A. N.* 3871 Mr. W. Stratanow gives a new determination of the light curve of this variable star from his own observations and also from the mean results of the six observers Schur 1878-1885, Plassmann 1888-1893, Pannekoek 1891-1894, Glasenapp 1892-1894, Menze 1895 and Stratanow 1895-1898. A remarkable feature of the curve is the series of waves superposed upon the general curve, which seem to persist in the mean of the results of all the observers and which, therefore, cannot be neglected in constructing a theory of the stars variation.

Suspected Variable Near R Cygni.—In *A. J.* 545 Professor Ormond Stone, Director of the Leander McCormick Observatory, calls attention to a star 14^s preceding and 0′.8 north of 7045 R Cygni, which was seen on July 15, 1903 to be of the 10.8 magnitude. On July 18 and 19 it was estimated at 14.5^m and 14.7^m respectively. No star is shown in this place on Hagen's chart.

Observations of Variable Stars.

S Tauri.

The minimum of this variable was predicted for February 10, 1903, but it occurred somewhat earlier as shown by the following observations.

1902, Nov. 19, Dec. 1, 20, 24, 27, 28. Invisible in a four inch refractor.
1903, Jan. 29. Less than either of the stars of about 10th magnitude with which it forms a right angled triangle. It seems of about 10.5 magnitude.
" Feb. 1. Slightly increased. 10.2 mag.
" " 10. Equal to the adjacent stars of 10th mag. Moonlight.
" " 19 and 24. 9.7 mag.
" Mar. 3, 6, 8. 9.5 mag.
" " 17. Less t' an 10th mag.
" Apr. 2. Much dimmer. Scarcely 10.5 mag.

R Tauri.

R Tauri in the same field of view was also invisible in December, 1902.

1903, Jan. 29. Of 11th mag. Dimmer than S Tauri.
" Feb. 1. Increased to about 10.2 mag.
" " 10. 9.5 mag. brighter than S Tauri.
" " 12. Nearly of 9th mag.
" " 19. About 7.8 mag.
" " 24. " " "
" Mar. 3. Decreased to 8th mag.
" " 6 and 8. " " " . Moonlight.
" " 17. Slightly decreased.
" Apr. 2. Much dimmer. Of 8.5 mag.

The rapid rise of this variable was very noticeable as it amounted to three magnitudes in a month.

W Lyræ.

The maximum attained towards the beginning of last March was somewhat

less than that of August 1902 when the variable was of 8th magnitude. From 12th magnitude on December 29, it rose to 9.7 mag. during the following month, and on Feb. 15 was of 9th magnitude. The succeeding increase and decline were observed as follows:

1903, Feb. 21. 8.8 mag.
" " 28. 8.6 mag. Morning clear.
" Mar. 6, 9, 18, 22. Still equal to "*a*" classed as 8.6 mag. Less than "*n*" of 8.1 magnitude.
" " 25. Slightly decreased. About 8.7 mag.
" Apr. 3. 8.8 mag. according to the comparison stars.
" " 11. Of 9th magnitude or nearer to the brightness of *e* than of *p*.
" " 22. 9.8 mag.
" May 1. 10.5 mag.
" " 12. 11 mag.
" June 1. 12 mag. Just discernible.
" " 17, 22, 25, 29, 30. Not visible.
" July 1, 3, 6. Invisible. A high power was used on the 6th in clear moonlight.

SS CYGNI.

1903, June 23, 8:50 P. M. 2/10 less than *b* of 8.5 mag.; brighter than *a* which is 9.5 mag.
" " 24, 9:15 " Noticeably decreased but brighter than *a*.
" " 25, 9:25 " " " " " " " "
" " 26, 9:30 " " " " " " " "
" " 27, 9:05 " Equal to *a*.
" " 29, 9:00 " " "
" " 30, 9:17 " Slightly less than *a* but distinctly brighter than *d* of 10.5 mag.
" July 1, 9:20 " Between *a* and *d* but nearer to *d*.
" " 2, 9:20 " Dimmer in haze and moonlight; *d* not seen.
" " 3, 9:25 " Barely discernible in haze and moonlight.
" " 4, and 5. About equal to *d*. Hazy nights.
" " 6 Less than *d* in clear moonlight.

V CORONÆ.

It is difficult to find this star without circles, but the field of view was fully identified by means of the chart in POPULAR ASTRONOMY for March 1894. It is between the two comparison stars used, but the estimates of magnitude are approximations founded on experienced observations only, as no classified estimates were available. The maximum was expected on March 26.

1902, Mar. 26. 10th magnitude.
" " 29. " "
" Apr. 8. About 9.5 mag.
" " 13. " "
1902, Apr. 26. Of 9th mag.
" May 1, 8, 14. The same.
1903, Apr. 22. Nearly of 9th mag.
" May 1. 8.5 mag.

The increase was distinct but later observations were not obtainable.

U DRACONIS.

1902, May 11. 9.5 mag.
" " 14. " "
" " 27. 10th mag.
" June 1. 10.5 mag.
" " 7. " "
" " 8. " "
1902, June 16. It seems of 11th mag. in moonlight.
" " 24. 10.8 mag. It is slightly brighter than a star than a star classed as 11th mag.
" " 26. 11th mag.

X VIRGINIS.

1902, April 12, 24, May 2 and 8 this variable was of about 11th magnitude. On May 11, 27 and 29 it was brighter, but still less than 10th mag.

W AURIGÆ.

The period of this star seems to be irregular. Having become invisible in December last, its reappearance was expected in January, but on the 14, 17, 27 and February 2, it was still invisible though the comparison stars of 11th and 12th magnitude were distinctly seen. ROSE O'HALLORAN.

New Variable Star 19.1903 Lyræ.—This is announced by Mr. A. Stanley Williams in *A. N.* 3880. Its position is

R. A. $= 18^h\ 38^m\ 13^s.9$; Decl. $+ 32°\ 39'.1$ (1855)

and its variation is from 9.9^m to 11.2^m. It seems to be of the "Antalgol Type," having a light curve which almost exactly resembles that of Y Lyrae and UY Cygni, but is of a more exaggerated type. Mr. Williams gives the following elements:

Period of variation.....$0^d\ 12^h\ 16^m\ 15^s.0 = 0^d.511284$
Epoch of maximum.....1903 May 31, $13^h\ 51^m$ Gr. M. T.
$= \text{J. D. } 2416266^d.5768$
Maximum brightness.....9.87 mag.; minimum 11.23 mag.

	h	m
Minimum to maximum.....	1	1
Maximum to minimum.....	11	15

Ratio of increase to decrease.....0.09.

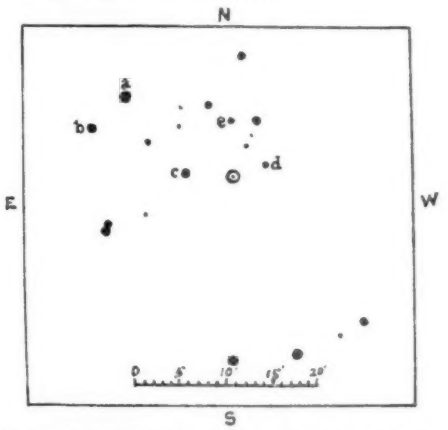


CHART OF THE NEW VARIABLE STAR 19.1903 LYR.E.

A portion of the ephemeris computed by Mr. Williams follows:

E.	1903, Gr. M. T.	h	m	E.	1904, Gr. M. T.	h	m
2827	Sept. 13	9	22				
2872	Oct. 6	9	33	3052	Jan. 6	10	11
2917	29	9	44	3097	29	10	29
2962	Nov. 21	9	55				
3007	Dec. 14	10	06				

Mr. Williams gives for the magnitudes of the comparison stars marked in the diagram:

$a = 9.00$ $b = 9.98$ $c = 10.33$ $d = 10.91$ $e = 11.23$.

Minima of Variable Stars of the Algol Type.

[Greenwich Mean Time beginning with midnight. The hours greater than 12 are those of the afternoon. To obtain Eastern Standard time subtract 5 hours; for Central Standard subtract 6 hours, etc. Alternate minima only are given for these months.]

U Cephei.

	d	h
Sept.	3	12
	8	12
	13	11
	18	11
	23	10
	28	10
Oct.	3	10
	8	9
	13	9
	18	9
	23	8
	28	8

Z Persei

	d	h
Sept.	3	17
	9	20
	15	22
	22	1
	28	4
Oct.	4	6
	10	9
	16	12
	22	15
	28	17

Algol.

	d	h
Sept.	3	1
	8	18
	14	12
	20	6
	25	23
Oct.	1	17
	7	10
	13	4
	18	22
	24	15
	30	9

λ Tauri.

	d	h
Sept.	2	13
	10	11
	18	8
	26	6
Oct.	4	4
	12	2
	19	23
	27	21

RR (R^2) Puppis

	d	h
Sept.	1	20
	14	17
	27	13
Oct.	10	10
	23	6

V Puppis

	d	h
Sept.	3	7
	6	4

V Puppis.

	d	h
Sept.	9	2
	12	0
	14	22
	17	20
	20	18
	23	16
	26	13
	29	11
Oct.	2	9
	5	7
	8	5
	11	2
	14	0
	16	22
	19	20
	22	18
	25	15
	28	13
	31	11

S Cancri

	d	h
Sept.	8	4
	27	3
Oct.	16	2

S Antliæ.

Period $7^h\ 46^m.8$

	d	h
Sept.	4	10
	6	9
	8	8
	10	6
	12	5
	14	4
	16	2
	18	1
	20	0
	21	22
	23	21
	25	20
	27	18
	29	17
Oct.	1	16
	3	14
	5	13
	7	12
	9	10
	11	9
	13	8
	15	6
	17	5
	19	4
	21	2
	23	1
	25	0
	26	22
	28	21
	30	20

S Velorum.

	d	h
Sept.	4	15
	16	12
	28	9
Oct.	10	6
	22	3

U Coronæ.

	d	h
Sept.	7	3
	14	0
	20	22
	27	20
Oct.	4	18
	11	15
	18	13
	25	11

R Aræ.

	d	h
Sept.	8	15
	17	11
	26	8
Oct.	5	4
	14	0
	22	21
	31	17

U Ophiuchi.

	d	h
Sept.	3	17
	5	9
	7	1
	8	17
	10	10
	12	2
	13	18
	15	10
	17	3
	18	19
	20	11
	22	3
	23	20
	25	12
	27	4
	28	20
	30	12
Oct.	2	5
	3	21
	5	13
	7	6
	8	22
	10	14
	12	7
	13	23
	15	15
	17	8
	19	0
	20	16
	22	8
	24	1

U Ophiuchi.

	d	h
Oct.	25	17
	27	9
	29	1
	30	18

Z Herculis.

	d	h
Sept.	2	22
	6	22
	10	22
	14	22
	18	22
	22	21
	26	21
	30	21
Oct.	4	21
	8	21
	12	20
	16	20
	20	20
	24	20
	28	20

RS (S^2) Sagittarii.

	d	h
Sept.	1	11
	6	7
	11	3
	15	23
	20	19
	25	15
	30	11
Oct.	5	7
	10	3
	14	23
	19	19
	24	15
	29	11

RX (X^2) Herculis.

	d	h
Sept.	1	19
	3	14
	5	9
	7	4
	8	22
	10	17
	12	12
	14	6
	16	1
	17	20
	19	14
	21	9
	23	4
	24	22
	26	17
	28	12
	30	6

RX (X^2) Her.

	d	h
Oct.	2	1
	3	20
	5	14
	7	9
	9	4
	10	22
	12	17
	14	12
	16	7
	18	1
	19	20
	21	15
	23	9
	25	4
	26	23
	28	17
	30	12

RV (V^2) Lyræ.

	d	h
Sept.	2	11
	9	16
	16	21
	24	2
Oct.	1	6
	8	11
	15	16
	22	21
	30	1

U Sagittæ.

	d	h
Sept.	2	4
	8	22
	15	16
	22	10
	29	5
Oct.	5	23
	12	17
	19	12
	26	6

SY (X^3) Cygni.

	d	h
Sept.	4	20
	16	21
	28	21
Oct.	10	21
	22	22

SW (V^3) Cygni.

	d	h
Sept.	2	15
	11	18
	20	21
	30	1
Oct.	9	5
	18	8
	27	11

Minima of Variable Stars of the Algol Type.—Continued.

UW (Z⁴) Cygni.			UW Cygni.			Y Cygni.			Y Cygni.			Y Cygni.		
	d	h		d	h		d	h		d	h		d	h
Sept.	6	1	Oct.	31	6	Sept.	3	22	Sept.	24	21	Oct.	15	21
	12	22	W Delphini.				6	22		27	21		18	21
	19	20	Sept.	9	5		9	22		30	21		21	20
	26	18		18	19		12	22	Oct.	3	21		24	20
Oct.	3	15		28	10		15	21		6	21		27	20
	10	13	Oct.	8	1		18	21		9	21		30	20
	17	11		17	16		21	21		12	21			
	24	8		27	6									

Approximate Magnitudes of Variable Stars Aug. 10, 1903.

[Communicated by the Director of Harvard College Observatory, Cambridge, Mass.]

Name.	R. A. 1900.		Decl. 1900.		Magn.	Name.	R. A. 1900.		Decl. 1900.		Magn.
	h	m	°		h		h	m	°		h
T Androm.	0	17.2	+ 26	26	11*d*	R Camel.	14	25.1	+ 84	17	10*i*
T Cassiop.	0	17.8	+ 55	14	9*i*	R Bootis	14	32.8	+ 27	10	7*i*
R Androm.	0	18.8	+ 38	1	13*f*	S Librae	15	15.6	— 20	2	11*d*
S Ceti	0	19.0	— 9	53	*u*	S Serpentis	15	17.0	+ 14	40	8*i*
W Cassiop.	0	49.0	+ 58	1	*u*	S Coronae	15	17.3	+ 31	44	12*d*
S "	1	12.3	+ 72	5	9*d*	S Urs. Min.	15	33.4	+ 78	58	*f*
R Piscium	1	25.5	+ 2	22	*u*	R Coronae	15	44.4	+ 28	28	6
R Trianguli	1	31.0	+ 33	50	*u*	V "	15	45.9	+ 39	52	*u*
U Persei	1	52.9	+ 54	20	*u*	R Serpentis	15	46.1	+ 15	26	8*i*
R Arietis	2	10.4	+ 24	36	*u*	R Herculis	16	1.7	+ 18	38	*f*
o Ceti	2	14.3	— 3	26	*u*	R Scorpii	16	11.7	— 22	42	*f*
S Persei	2	15.7	+ 58	8	*u*	S "	16	11.7	— 22	39	*f*
R Ceti	2	20.9	— 0	38	*u*	U Herculis	16	21.4	+ 19	7	12*d*
U "	2	28.9	— 13	35	*u*	R Ursae Min.	16	31.3	+ 72	28	*u*
R Persei	3	23.7	+ 35	20	*u*	W Herculis	16	31.7	+ 37	32	13*d*
R Tauri	4	22.8	+ 9	56	*s*	R Draconis	16	32.4	+ 66	58	8*d*
S "	4	23.7	+ 9	44	*s*	S Herculis	16	47.4	+ 15	7	12*i*
R Aurigæ	5	9.2	+ 53	28	*f*	R Ophiuchi	17	2.0	— 15	58	*f*
U Orionis	5	49.9	+ 20	10	*s*	T Herculis	18	5.3	+ 31	0	12*d*
R Lyncis	6	53.0	+ 55	28	12*i*	R Scuti	18	42.2	— 5	49	6
R Gemin.	7	1.3	+ 22	52	*s*	R Aquilae	19	1.6	+ 8	5	7*d*
S Canis Min.	7	27.3	+ 8	32	*s*	R Sagittarii	19	10.8	— 19	29	11*d*
R Cancri	8	11.0	+ 12	2	*s*	S "	19	13.6	— 19	12	*u*
V "	8	16.0	+ 17	36	*s*	R Cygni	19	34.1	+ 49	58	*f*
S Hydrae	8	48.4	+ 3	27	*s*	RT "	19	40.8	+ 48	32	*f*
T "	8	50.8	— 8	46	*s*	X "	19	46.7	+ 32	40	11*i*
R Leo. Min.	9	39.6	+ 34	58	11*i*	S Cygni	20	3.4	+ 57	42	11*i*
R Leonis	9	42.2	+ 11	54	7*i*	RS "	20	9.8	+ 38	28	8*d*
R Urs. Maj.	10	37.6	+ 69	18	9*i*	R Delphini	20	10.1	+ 8	47	12*i*
R Comae	11	59.1	+ 19	20	*u*	U Cygni	20	16.5	+ 47	35	10*d*
T Virginis	12	9.5	— 5	29	*f*	V "	20	38.1	+ 47	47	*f*
R Corvi	12	14.4	— 18	42	*s*	T Aquarii	20	44.7	— 5	31	7*i*
Y Virginis	12	28.7	— 3	52	9	R Vulpec.	20	59.9	+ 23	26	9*d*
T Urs. Maj.	12	31.8	+ 60	2	12*i*	T Cephei	21	8.2	+ 68	5	10*d*
R Virginis	12	33.4	+ 7	32	11	S "	21	36.5	+ 78	10	11*d*
S Urs. Maj.	12	39.6	+ 61	38	11*i*	S Lacertae	22	24.6	+ 39	48	*u*
U Virginis	12	46.0	+ 6	6	*f*	R "	22	38.8	+ 41	51	*u*
V "	13	22.6	— 2	39	13*f*	S Aquarii	22	51.8	— 20	53	*u*
R Hydrae	13	24.2	— 22	46	*s*	R Pegasi	23	1.6	+ 10	0	8*i*
S Virginis	13	27.8	— 6	41	10*i*	S "	23	15.5	+ 8	22	*u*
R Can. Ven.	13	44.6	+ 40	2	8*i*	R Aquarii	23	38.6	— 15	50	*u*
S Bootis	14	19.5	+ 54	16	13*f*	R Cassiop.	23	53.3	+ 50	50	11*i*

NOTE:—*f* denotes that the variable is probably fainter than the magnitude 13; *i*, that its light is increasing; *d*, that its light is decreasing; *s*, that it is near the Sun; *u*, that its magnitude is unknown.

Variable Stars of Short Period not of the Algol Type.

	Minimum.		Maximum.			Minimum.		Maximum.	
		h		h			h		h
SU Cygni	Sept. 1	11	Sept. 2	19	T Crucis	Sept. 15	5	Sept. 17	6
V Centauri	1	14	3	1	Y Sagittarii	16	3	17	22
T Crucis	1	18	3	19	S Sagittae	16	12	19	22
T Vulpeculae	1	20	3	5	SU Cygni	16	19	18	3
R Crucis	2	9	3	18	S Triang. Austr.	16	23	19	1
η Aquilae	3	5	5	11	δ Cephei	16	13	18	4
TX Cygni	3	6	8	9	η Aquilæ	17	14	19	20
U Vulpeculae	3	6	5	9	Y Ophiuchi	17	18	23	23
W Geminorum	3	6	5	21	TX Cygni	18	0	23	3
S Normae	3	16	8	2	U Sagittarii	18	2	21	1
X Cygni	3	23	10	18	V Centauri	18	2	19	13
W Virginis	4	0	12	5	V Velorum	18	4	19	3
κ Pavonis	4	4	7	23	T Velorum	18	13	19	22
S Trianguli Austr.	4	6	6	8	S Crucis	18	15	20	3
S Crucis	4	13	6	1	W Geminorum	18	18	21	9
Y Sagittarii	4	14	6	9	RV Scorpii	19	0	20	10
T Velorum	4	15	6	0	U Vulpeculae	19	5	21	8
U Sagittarii	4	16	7	15	V Carinae	19	13	21	17
ζ Geminorum	4	20	9	20	T Vulpeculae	19	14	20	23
V Velorum	5	1	6	0	U Aquilae	19	17	21	21
SU Cygni	5	7	6	15	R Crucis	19	21	21	6
U Aquilae	5	15	7	19	S Muscae	20	5	23	16
δ Cephei	5	20	7	11	β Lyrae	20	8	23	16
V Carinae	6	4	8	8	X Cygni	20	8	27	3
T Vulpeculae	6	7	7	16	SU Cygni	20	16	22	0
RV Scorpii	6	21	8	7	T Monocerotis	21	6	29	4
V Centauri	7	2	8	13	δ Cephei	21	22	23	13
W Sagittarii	7	8	10	8	Y Sagittarii	21	22	23	17
β Lyrae	7	10	10	17	T Crucis	21	22	23	23
S Sagittae	8	3	11	13	κ Pavonis	22	8	26	3
R Crucis	8	5	9	14	W Sagittarii	22	13	25	13
T Crucis	8	11	10	12	V Velorum	22	13	23	12
SU Cygni	9	3	10	11	S Normae	23	4	27	14
T Velorum	9	6	10	15	T Velorum	23	4	24	13
S Crucis	9	6	10	18	S Triang. Austr.	23	7	25	9
V Velorum	9	10	10	9	S Crucis	23	8	24	20
Y Sagittarii	10	9	12	4	V Centauri	23	13	25	1
η Aquilae	10	9	12	15	T Vulpeculae	24	0	25	9
S Muscae	10	13	14	0	SU Cygni	24	12	25	20
S Trianguli Austr.	10	14	12	17	η Aquilae	24	18	27	0
T Vulpeculae	10	17	12	2	U Sagittarii	24	20	27	19
W Geminorum	11	0	13	15	S Sagittae	24	22	28	8
U Vulpeculae	11	6	13	9	RV Scorpii	25	2	26	12
U Sagittarii	11	8	14	7	ζ Geminorum	25	4	30	4
δ Cephei	11	5	12	20	R Crucis	25	16	27	1
V Centauri	12	14	14	1	V Carinae	26	6	28	10
U Aquilae	12	16	14	20	W Geminorum	26	11	29	2
V Carinae	12	20	14	24	U Aquilae	26	17	28	21
SU Cygni	12	23	14	7	β Lyrae	26	20	29	22
RV Scorpii	12	23	14	9	V Velorum	26	22	27	21
κ Pavonis	13	6	17	1	U Vulpeculae	27	5	29	8
S Normae	13	10	17	20	δ Cephei	27	7	28	22
V Velorum	13	19	14	18	Y Sagittarii	27	17	29	12
β Lyrae	13	21	16	23	T Velorum	27	19	29	4
T Velorum	13	21	15	6	S Crucis	28	1	29	13
S Crucis	13	22	15	10	SU Cygni	28	9	29	17
R Crucis	14	1	15	10	T Vulpeculæ	28	11	29	20
W Sagittarii	14	23	17	23	T Crucis	28	16	30	17
ζ Geminorum	15	0	20	0	V Centauri	29	1	30	12
T Vulpeculae	15	3	16	12	S Triang. Austr.	29	15	31	17

Variable Stars of Short Period not of the Algol Type.—Continued.

	Minimum.	h	Maximum.	h
S Muscae	Sept. 29	21	Oct. 3	8
W Sagittarii	30	3	3	3
RV Scorpii	Oct. 1	3	2	13
V Velorum	1	7	2	6
κ Pavonis	1	10	5	5
U Sagittarii	1	14	4	13
η Aquilae	1	22	4	4
SU Cygni	2	5	3	13
T Velorum	2	10	3	19
R Crucis	2	12	3	21
δ Cephei	2	16	4	7
TX Cygni	2	17	7	20
S Crucis	2	17	4	5
V Carinae	2	22	5	2
T Vulpeculæ	2	21	4	6
S Normae	2	22	7	8
S Sagittae	3	7	6	17
β Lyræ	3	7	6	14
Y Sagittarii	3	11	5	6
U Aquilae	3	18	5	22
W Geminorum	4	5	6	20
V Centauri	4	13	6	0
Y Ophiuchi	4	20	11	1
U Vulpeculae	5	4	7	7
ζ Geminorum	5	7	10	7
T Crucis	5	9	7	10
S Trianguli Austr.	5	22	8	0
SU Cygni	6	1	7	9
X Cygni	6	17	13	12
T Velorum	7	2	8	11
RV Scorpii	7	5	8	15
R Crucis	7	8	8	17
T Vulpeculae	7	8	8	17
S Crucis	7	10	8	22
W Sagittarii	7	17	10	17
δ Cephei	8	1	9	16
U Sagittarii	3	7	11	6
η Aquilæ	9	2	11	8
Y Sagittarii	9	6	11	1
S Muscae	9	13	13	0
V Carinae	9	15	11	19
β Lyræ	9	18	12	20
SU Cygni	9	21	11	5
V Velorum	10	0	10	23
V Centauri	10	1	11	12
κ Pavonis	10	12	14	7
U Aquilae	10	18	12	22
S Sagittae	11	16	15	2
T Velorum	11	17	13	2
T Vulpeculæ	11	18	13	3
W Geminorum	11	23	14	14
S Crucis	12	2	13	14
T Crucis	12	3	14	4
S Trianguli Austr.	12	6	14	8
S Normae	12	16	17	2
R Crucis	13	4	14	13
U Vulpeculae	13	4	15	7
RV Scorpii	13	6	14	16
δ Cephei	13	9	15	0
SU Cygni	13	18	15	2
V Velorum	14	9	15	8
Y Sagittarii	15	0	16	19
U Sagittarii	15	1	18	0
ζ Geminorum	15	11	20	11

Maxima and Minima of Long Period Variables.

[Computed from Chandler's "Third Catalogue." A question mark indicates that the elements are in doubt. By Misses Ida I. Watson and Helen M. Swartz of Vassar College Observatory.]

Maxima.

Date Oct,	No.	Star.
3	5928?	T Ophiuchi
4	2445?	W Monocerotis
4	5761	Z Scorpii
6	3825	R Ursae Majoris
8	3493	R Leonis
12	8622	W Ceti
13	2691	T Canis Minoris
14	5593	W Librae
16	5795	W Scorpii
20	5830	R Scorpii
20	7252	W Capricorni
25	7120	X Cygni
28	6512	T Herculis
29	659?	X Cassiopeae
30	6207	Z Ophiuchi
30	8600	R Cassiopeae

Minima.

Date. Oct.	No.	Star.
1	6849	R Aquilae
2	976	T Arietis
2	715	S Arietis
5	2258	V Aurigae
7	3994	S Leonis
8	5758	X Herculis
9	1577	R Tauri
13	1855	R Aurigae
15	5950	W Herculis
16	294?	W Cassiopeae
18	7754	W Cygni
18	5504	S Coronae
20	7299	U Cygni
26	7560	R Vulpeculae
30	7242	S Aquilae

Maxima of UY Cygni.

Period $13^h\ 27^m\ 21^s$. The minimum occurs $1^h\ 53^m$ before the maximum.

	h		h		h		h
Sept. 1	12	Sept. 17	5	Oct. 1	19	Oct. 17	11
2	15	18	8	3	22	18	14
3	18	19	11	4	1	19	17
4	21	20	14	5	4	20	20
6	0	21	16	6	6	21	23
7	3	22	19	7	9	23	2
8	6	23	22	8	12	24	5
19	8	25	1	9	15	25	8
10	11	26	4	10	18	26	11
11	14	27	7	11	21	27	14
12	17	28	10	13	0	28	17
13	20	29	13	14	3	29	20
14	23	30	16	15	6	30	22
16	2			16	9		

Maxima of U Pegasi.

Period $4^h\ 29^m.8$. The minimum occurs $2^h\ 15^m$ after the maximum.

	d	h	d	h	d	h	d	h
Sept.	1	2	Sept. 17	0	Oct. 1	1	Oct. 16	1
	2	0	18	3	2	0	17	0
	3	3	19	1	3	3	18	3
	4	2	20	0	4	1	19	1
	5	0	21	3	5	0	20	4
	6	3	22	1	6	3	21	3
	7	2	23	0	7	1	22	1
	8	0	24	3	8	0	23	4
	9	3	25	1	9	3	24	2
	10	2	26	0	10	1	25	1
	11	0	27	3	11	0	26	4
	12	3	28	1	12	3	27	2
	13	1	29	0	13	1	28	1
	14	0	30	3	14	0	29	4
	15	3			15	3	30	2
	16	1					31	1

Maxima of Y Lyræ.

Period $12^h\ 3.9^m$.

	d	h	d	h	d	h	d	h
Sept.	1	23	Sept. 16	1	Oct. 1	3	Oct. 16	5
	2	23	17	1	2	3	17	5
	3	23	18	1	3	3	18	5
	4	23	19	1	4	3	19	5
	5	23	20	1	5	3	20	5
	6	23	21	1	6	3	21	5
	8	0	22	1	7	3	22	5
	9	0	23	2	8	4	23	5
	10	0	24	2	9	4	24	6
	11	0	25	2	10	4	25	6
	12	0	26	2	11	4	26	6
	13	0	27	2	12	4	27	6
	14	0	28	2	13	4	28	6
	15	1	29	2	14	4	29	6
			30	3	15	4	30	6
							30	6

GENERAL NOTES.

Owing to the increased demand for Mr. E. W. Maunder's popular work "Astronomy without a Telescope," only lately issued, the publishers have prepared a second impression which is now ready.

The corner stone of the new Observatory on Wilder Hill, for Amherst College, was laid June 23d, at high noon with an appropriate program. In addition to the usual devotional and corner-stone-laying exercises there was given a story of the corner stone and an Ode written for the occasion by Mrs. C. E. Whiton-Stone.

α Coronæ Borealis a Spectroscopic Double.—In *A. N.* 3890 Mr. J. Hartman gives results of measurement of seven spectrograms of this familiar star, which reveal a range of motion in the line of sight of from $+ 38^{km}$ to $- 20^{km}$. The period is about 17 days.

The Flattening of the Planet Uranus.—In *A. N.* 3889 Mr. O. Bergstrand of Upsala, Sweden, discusses the measures of this planet by the observers Lassell, Hall, Holden, Barnard, Schaeberle, Hussey, Aitken, and See. He finds as a rough approximation to the flattening of the planet 1/17, and from this deduces as the theoretical period of rotation $11^h.5$.

Fifth Satellite of Jupiter.—E. E. Barnard of Yerkes Observatory has published an extended article in *The Astronomical Journal* of August 8, 1903, on the Fifth Satellite of Jupiter. Observations of this satellite were made in July, August and September of the past year. The circumstances of observation were not very favorable but a sidereal period for the satellite was found to be,

$$0^d\ 11^h\ 57^m\ 22^s.6698 \pm 0^s.0052.$$

The probable error of a single determination is $0^s.007$ and the mean daily motion in the orbit is $722°.631636$.

In this discussion an interesting feature of the satellite's orbit is noticed at length. It is the fact of the rapid motion of the line of apsides ($+ 2°.42$ daily, or $883°.9$ a year) as determined by the longitude of the perijove.

In the elements of the orbit given in this article, the mean distance of the satellite from Jupiter is given as 112,670 miles.

Spoerer's Law of Sunspot Zones.—The so-called Spöerers law of sunspot zones or latitudes is a well-known phase of solar activity, although the reasons for it are not yet understood. It describes a disturbance of the solar surface in two belts about 30° north and south of the Sun's equator. The peculiarity of this disturbance is the fact that the north and south lines of activity gradually move towards the equator, and when they have reached the latitude of 16°, the maximum of Sun spottedness occurs some thirteen or fourteen years after its first appearance. When this disturbing wave has reached a solar latitude of about 5° or 10°, it dies out. Two or three years before its disappearance two new zones of activity show themselves in latitude 30° to 35°, thus making four well-defined spot-belts, at the spot minimum, two in the higher latitudes that are new, and two in the lower latitudes that are disappearing.

E. Walter Maunder, in *Observatory* for August 1903, mentions two points which he claims are not brought out in Spöerer's law. One is, in the behavior of separate spot groups, "it is striking to note how often a group at the time of one

of the short subordinate maximum tends to break out at a latitude somewhat above the mean latitude for that particular epoch." The other point concerns small spots of very brief appearance in latitude above 32°. "Such spots are so small and so short-lived, that they exercise practically no effect on any mean places, nor can they be truly said to create a fresh zone." If a spot appears for a single day in a year with small area it certainly could not be thought of as at all important when the spotted area of the rest of the Sun was, in the mean of the whole year some 30,000 to 50,000 times as great."

The Harvest Moon.—An interested correspondent has been reading about the Harvest Moon, so-called, and thinks that the definition which he has seen is uncertain. He says: "The Harvest Moon is usually defined as the full Moon nearest the autumnal equinox, because it rises for several successive evenings with comparatively little variation in time at the period when the harvests are annually in Great Britain." He then quotes from the *Tribune Almanac* for the months of June, July, August, September and October, 1902 and 1903 and finds that the shortest time between successive risings of the Moon occurred in July for 1902 and in October, 1903, and asks if the July full Moon of 1902 should not be called the Harvest Moon.

It would seem that our correspondent emphasizes the phrase "shortest time" between successive Moon risings too much. It should be borne in mind that the names Harvest Moon and Hunters' Moon were given because of the advantage afforded to the husbandmen and the hunters of early times in Great Britain, and not because the very shortest period of Moon rising retardation was intended to be marked. Our correspondent will notice that the numbers given for both years for the months of July, August and September only vary from three to six minutes, a time too short for notice when the name Harvest Moon was given.

Our correspondent will also know that the expression "nearest the autumnal equinox" is loosely used. It does not mean the Moon rising in the part of the sky where the autumnal equinox is, for the Moon rising in autumn, at its full, in English harvest time, is near the vernal equinox, the Sun being near the autumnal equinox.

The White Spot on Saturn.—In reply to your inquiries about the rotation period of the white spot on Saturn, I have only approximately determined it, and am waiting until the close of the season to work out the exact period.

It has been stated in other publications that the motion of the spot closely represents the period of $10^h\ 14^m$ determined by Professor Hall from the white spot of 1876. I am unable to verify this statement. The period of the present spot or spots (for there are several) appear to be much longer—fully 25 minutes longer.

The first observations of this spot were printed in *A. J.* 542-543.

The spot transitted the central meridian of Saturn June 23, $15^h\ 42^m$ (Central Standard time.) At the second observation, on June 24, it was seen that the period must be much longer than that of 1876 to represent the two observations. According to the old period the spot should have transitted at about $12^h\ 10^m$ on the 24th. It did not transit, however, until close to $13^h\ 0^m$ or 50 minutes later than prediction, agreeing with a period of about $10^h\ 39^m$.

A rough approximation has since given a period of $10^h\ 38^m.9 \pm$.

In *A. N.* 3883 K. Graff, of the Hamburg Observatory gets a period of $10^h\ 39^m.01$ from the present spot.

In all the various determinations of the rotation periods of Jupiter from the different spots no such large difference as is shown between the period of this spot on Saturn and the one of 1876, has been found.

E. E. BARNARD.

YERKES OBSERVATORY, Williams Bay, Wis.
August 24, 1903.

The Study of Mars.—The fifth report of the section for the observation of the planet Mars in the British Astronomical Association has been received. It is a document of about sixty pages showing a large amount of work during the years 1900 and 1901. Thirteen members of the Association were concerned under the direction of E. M. Antoniadi of Juvisy, France. The instruments used vary in size and kind from 3 inches aperture to 49¼ inches. The prevailing size being from 6 to 8 inches. The drawings made by these observers of the different features of the planet that were presented to the Section for this report were 146. The places of observation were in England, France, Ceylon and India.

Capt. P. B. Molesworth, of Trincomalee, Ceylon, made 71 fine drawings and charts which were lent the Director for this report.

The things systematically observed were the colors of the planet's disc, the terminator, seasonal variation in the darkness of the "Maria," the lakes, the canals, gemination, the canals considered as edges to faint shadings, the canals in the dark regions, bright spots on the disc of the planet, and projections on the terminator and the whitening of the lands with the obliquity of the solar rays.

This last point is one of interest and so far as we know quite new. Mr. Atkins, the observer who gave attention to the changes in color from sunrise to sunset, says, "from an analysis of the phenomena it will be noticed that there is undoubtedly a gradual change from white at sunrise to a ruddy tint at sunset. . . . Elysium, Tempe and Amazonis appear to attain their brightest yellow or red tint at Martian noon, whereas Libya and Aeria do not seem to lose their whiteness until well past the central meridian, probably owing to their being further south."

This observer says: "It seems hard to escape from the explanation that the appearances are caused by the gradual melting of deposits of hoar frost accumulated during the Martian nights."

Another interesting feature is described under the head of bright spots on the disc of Mars and projections on the terminator. On Jan. 2, 1901 one appeared, as a most brilliant white spot on the southwest terminator, as a projection, though that effect may possibly have been caused by irradiation; probably not, however; it more likely was a real projection. If the observers are not mistaken it had a height of 67 miles, and another projection observed had a height of 70 miles. Neither of these results were corrected for irradiation.

Considerable attention in this report is given to the study of the canals of Mars. Quotations from letters received from Capt. Molesworth are given prominence. He says: "What has struck me most during this apparition is that almost all the canals appear as streaks and not as lines. This streaky aspect can not be ascribed to the imperfect seeing of a narrow black line. Curiously enough I have found their appearance more streaky with the 12½ inch than I did with the 9¼ inch. * * *

"Some few of the canals, a very few, are sharp and line like, but the great majority are diffuse with all powers, even when seen under perfect definition in

most favorable circumstances. I cannot regard the delicate spider web appearance shown in Lowell's drawings, as being in the least a true rendering of the actual appearance of the canals."

We are surprised at the estimate of Mr. Lowell's work in the last paragraph. The writer must know the circumstances under which Mr. Lowell worked, using a 24-inch Clark glass and smaller instruments, having able professional assistance, doing all his work thoroughly as we have reason to believe. Last but not least, he had a locality at Flagstaff for observation that was very superior in regard to steadiness and purity of air. American astronomers have not questioned, so far as we know, the existence of the markings that Mr. Lowell has claimed to see, although they have not always supported the inferences that he has drawn from his observations. It is but just to Mr. Lowell to say that no other Observatory in this country has done, or claimed to do, as thorough, painstaking and continuous work in the study of Mars as that which has been done at Flagstaff, Arizona. We will not say that it is unprofessional to estimate his work as this observer does, but we will say that its candor and justice disappoint us very much.

We should like to consider other features of this report but space forbids.

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